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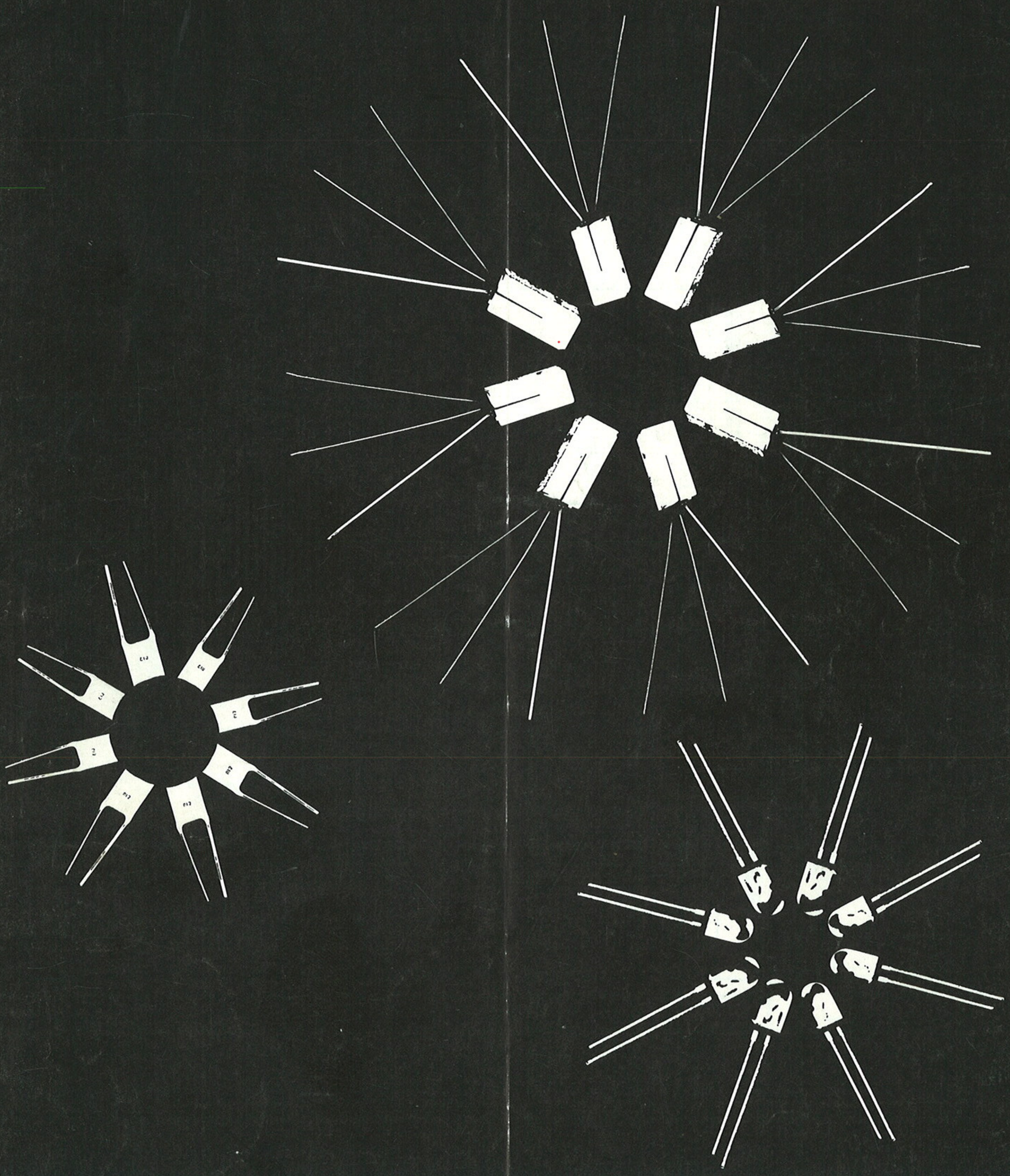
U.S.A.|Can. $1.50

elektor

up-to-date electronics for lab and leisure



Austria	S. 33	France	F. 7	Norway	Kr. 9
Belgium	F. 55	Germany	DM. 3.80	Sweden	Kr. 9
Denmark	Kr. 9	Netherlands	DFL. 3.25	Switzerland	F. 4.40

TRANSISTORS

AC107	0.23
AC125	0.19
AC126	0.15
AC127	0.15
AC127K	0.23
AC128	0.12
AC128K	0.25
AC141	0.18
AC142	0.18
AC142 01	0.19
AC151	0.19
AC153	0.13
AC153K	0.18
AC176	0.12
AC176K	0.16
AC187	0.16
AC187K	0.18
AC187 188	0.35
AC188	0.16
AC188K	0.18
ACY17	0.72
ACY28	0.19
AD143	0.70
AD149	0.50
AD161	0.35
AD161 162	0.70
AD162	0.35
AF116	0.16
AF117	0.20
AF118	0.40
AF124	0.25
AF125	0.28
AF126	0.25
AF127	0.25
AF139	0.19
AF178	0.29
AF179	0.29
AF180	0.29
AF181	0.29
AF186	0.29
AF239	0.29
ASY26	0.48
ASY27	0.29
ASY29	0.62
ASY73	0.29
ASZ17	0.59
AU107	1.00
AU113	0.90
AU210	0.90
BC107	0.06
BC107A	0.06
BC107B	0.06
BC108	0.06
BC108A	0.06
BC108B	0.06
BC109	0.06
BC113	0.10
BC114	0.10
BC115	0.10
BC116	0.11
BC116A	0.12
BC117	0.11
BC118	0.10
BC119	0.20
BC147	0.06
BC148	0.06
BC149	0.06
BC153	0.10
BC154	0.15
BC157	0.06
BC158	0.06
BC159	0.06
BC168	0.10
BC169	0.06
BC170	0.06
BC171	0.06
BC172	0.06
BC173	0.08
BC177	0.12
BC178	0.12
BC179	0.12
BC182L	0.09
BC183	0.09
BC183L	0.09
BC183LA	0.09
BC183LB	0.10
BC184	0.08
BC184L	0.09
BC186	0.19
BC187	0.19
BC204	0.08
BC204B	0.09
BC205	0.09
BC205A	0.10
BC206	0.10
BC206B	0.11
BC207	0.10
BC208	0.10
BC208B	0.11
BC208C	0.12
BC209	0.10
BC209B	0.11
BC212	0.10
BC212L	0.11
BC213	0.10
BC213L	0.10
BC214	0.10
BC214L	0.10
BC237	0.15
BC237A	0.16
BC237B	0.18
BC237C	0.21
BC238	0.15
BC238B	0.16
BC238C	0.18
BC239	0.21
BC251	0.10
BC251A	0.15
BC252B	0.17
BC252C	0.20
BC258	0.20
BC261	0.09
BC262	0.20
BC302	0.25
BC303	0.25
BC307	0.25
BC308	0.25
BC319C	0.25
BC327	0.09
BC327 16	0.10
BC328	0.09
BC337	0.09
BC338	0.09
BC347A	0.15
BC350A	0.17
BC441	0.20
BC461	0.24
BC537	0.29
BC547	0.10
BC547A	0.11
BC547B	0.11
BC547C	0.12
BC548A	0.11
BC548B	0.11
BC548C	0.11
BC557	0.09
BC557B	0.09
BC557C	0.10
BC558	0.09
BC559	0.09
BCX32	0.12
BCX36	0.12
BCY31	0.80
BCY40	0.50
BCY42	0.55
BCY58	0.20
BCY70	0.13
BCY71	0.13
BCY72	0.13
BCZ11	0.28
BD113	0.50
BD115	0.30
BD123	0.60
BD124	0.65
BD131	0.35
BD131 132	0.80
BD132	0.35
BD135	0.30
BD136	0.30
BD137	0.30
BD137 138	0.70
BD138	0.30
BD139	0.30
BD140	0.30
BD142	0.30
BD201	0.80
BD202	0.80
BD203	0.80
BD204	0.80
BD234	0.50
BD235	0.50
BD238	0.50
BD437	0.50
BDX77	0.90
BF153	0.08
BF178	0.20
BF179	0.20
BF180	0.15
BF181	0.15
BF182	0.15
BF183	0.15
BF184	0.15
BF185	0.15
BF194	0.06
BF195	0.06
BF196	0.06
BF197	0.06
BF200	0.25
BF202	0.30
BF203	0.30
BF324	0.20
BF336	0.25
BFS28	1.00
BFW10	0.40
BFW11	0.40
BFW30	1.00
BFW57	0.15
BFW58	0.15
BFX12	0.20
BFX29	0.20
BFX30	0.20
BFX84	0.27
BFX88	0.17
BFX89	0.17
BFY50	0.12
BFY51	0.12
BFY52	0.12
BFY90	0.50
BR101	0.26
BRY39	0.25
BRY56	0.25
BSV64	0.30
BSV79	0.75
BSV80	0.75
BSV81	0.85
BSX21	0.14
BSY40	0.27
BSY95A	0.12
BT106	0.96
BU105	1.50
BU126	0.80
BU204	1.50
BU205	1.60
BU207	1.80
OC22	1.40
OC29	0.85
OC44	0.12
OC45	0.12
OC71	0.09
OC72	0.12
OC75	0.10
OC81	0.12
OC82	0.48
TIP29A	0.40
TIP29B	0.45
TIP30	0.35
TIP30A	0.40
TIP30B	0.45
TIP31	0.35
TIP31A	0.40
TIP31B	0.45
TIP32	0.35
TIP32A	0.40
TIP32B	0.45
TIP41	0.35
TIP41A	0.40
TIP41B	0.45
TIP42	0.35
TIP42A	0.40
TIP42B	0.45
TIP2955	0.65
TIP3055	0.40
TIS90	0.18
2N393	0.30
2N404	0.29
2N456A	0.50
2N696	0.10
2N697	0.10
2N706	0.07
2N706A	0.08
2N708	0.08
2N918	0.36
2N929	0.14
2N987	0.12
2N1302	0.12
2N1303	0.15
2N1304	0.15
2N1307	0.20
2N1308	0.20
2N1309	0.20
2N1484	1.00
2N1507	0.15
2N1613	0.15
2N1671	1.10
2N1711	0.15
2N2218	0.15
2N2219A	0.18
2N2221	0.15
2N2222	0.15
2N2369	0.10
2N2401	0.30
2N2412	0.70
2N2483	0.22
2N2646	0.40
2N2904	0.15
2N2904A	0.15
2N2905	0.15
2N2905A	0.15
2N2906	0.12
2N2907A	0.12
2N2926G	0.08
2N29261	0.08
2N3053	0.12
2N3054	0.35
2N3055	0.35
2N3055 Motorola	0.50
2N3133	0.20
2N3442	1.00
2N3553	0.50
2N3702	0.08
2N3704	0.06
2N3705	0.06
2N3711	0.06
2N3715	1.89
2N3819	0.18
2N3903	0.10
2N3904	0.08
2N3905	0.08
2N3906	0.08
2N4058	0.10
2N4124	0.20
2N5036	0.30
2N5484	0.35

DIODES

AA119	0.17
AA121	0.11
AA129	0.08
AA143	0.15
AA144	0.09
BA102	0.30
BA111	0.98
BA115	0.25
BA145	0.15
BA148	0.12
BA154	0.10
BA155	0.12
BA156	0.12
BA157	0.45
BA158	0.65
BA159	0.75
BA182	0.45
BA201	0.15
BA243	0.85
BAX13	0.06
BAX16	0.07
BAX17	0.10
BB105B	0.35
BB105G	0.35
BB110G	0.45
BB142	1.25
BR100	0.20
BR101	0.30
BY100	0.20
BY103	0.35
BY118	1.45
BY126	0.15
BY127	0.10
BY130	0.15
BY133	0.10
BY134	0.45
BY142	0.45
BY164	0.50
BY176	3.45
BY179	0.90
BY182	1.85
BY184	0.70
BY187	1.30
BY198	0.75
BY199	0.55
BY201-2	0.40
BY201-3	0.40
BY201-4	0.45
BY201-5	0.55
BY201-6	0.55
BY203-12	0.60
BY203-16	0.65
BY203-20	1.00
BY204-4	0.45
BY204-8	0.65
BY204-10	0.75
BY206	0.30
BY210-400	0.45
BY210-600	0.50
BY210-800	0.55
BYX10	0.35
BYX55-350	0.45
BYX55-600	0.55
BYX71-350	0.90
BYX71-600	1.15
BZX61 series	0.18
BZY88 series	0.08
DK13	0.45
ITT44	0.10
ITT210	1.35
ITT827	2.35
ITT921	0.20
ITT923	0.35
ITT1075	0.25
ITT2001	0.25
ITT2002	0.20
MR502	0.75
MR813	0.90
MR854	1.80
MR856	2.10
MR992A	1.55
MV2203	1.60
MV5460	0.65
OA47	0.07
OA70	0.07
OA71	0.35
OA81	0.12
OA85	0.12
OA86	0.20
OA90	0.07
OA91	0.06
OA95	0.06
OA202	0.07
ST2	0.14
1N4001	0.04
1N4002	0.05
1N4003	0.05
1N4004	0.06
1N4005	0.06
1N4006	0.07
1N4007	0.08
1N4148	0.04
1N4150	0.45
1N4448	0.25
1N5401	0.12
1N5402	0.15
1N5403	0.15
1N5404	0.16
1N5405	0.25
1N5406	0.20
1N5407	0.19
1N5408	0.20
1N5450A	6.75
1N5761	0.60

LINEAR INTEGRATED CIRCUITS

CA3020	1.75
CA3046	0.80
CA3048	2.50
CA3065	1.58
CA3089E	7.88
CA3090Q	4.50
ETT6016	4.95
ETTR6016	4.95
MC1303L	1.50
MC1304P	2.00
MC1305	5.15
MC1307P	2.85
MC1310P	1.00
MC1327P	2.75
MC1327PQ	2.50
MC1330P	1.25
MC1339P	3.95
MC1349	3.35
MC1351P	1.25
MC1352P	1.45
MC1358PQ	3.85
SAA570	4.20
SAA700B	10.15
SAS560	2.75
SAS570	2.75
SBA750B	6.75
SC9503P	2.00
SC9504P	2.00
SL414A	4.85
SL415A	6.30
SL901B	8.50
SL917B	10.70
SL1310	5.65
SL1327	2.75
SL3046	2.60
SN76003N	2.50
SN76003ND	2.15
SN76013N	1.50
SN70613ND	2.15
SN76023N	1.50
SN76023ND	2.15
SN76033N	2.40
SN76110N	1.50
SN76131N	2.00
SN76226N	3.15
SN76226ND	3.15
SN76227N	2.50
SN76532N	3.15
SN76533N	2.70
SN76544N	1.80
SN76550N	1.80
SN76660N	0.80
SN76666N	1.60
TAA300	3.75
TAA310	3.15
TAA320	2.60
TAA350A	3.00
TAA435	3.40
TAA550	0.50
TAA550B	0.40
TAA570	2.85
TAA621	6.95
TAA630	8.55
TAA630S	5.10
TAA661A	1.70
TAA661B	1.80
TAA700	3.50
TAA840	4.50
TAD100	1.35
TBA120A	3.05
TBA120AS	1.50
TBA120S	2.70
TBA120SB	1.60
TBA120SQ	1.60
TBA281	4.70
TBA350A	3.00
TBA396	1.80
TBA440	3.60
TBA4406	3.95
TBA480Q	2.50
TBA400	2.25
TBA510	2.40
TBA510Q	2.50
TBA520	2.50
TBA520Q	2.50
TBA530	2.50
TBA530Q	2.50
TBA540	2.50
TBA540Q	2.25
TBA550	3.50
TBA550Q	3.80
TBA560	6.45
TBA560C	4.50
TBA560Q	7.35
TBA560CQ	3.00
TBA570	2.00
TBA570Q	2.00
TBA641A12	6.20
TBA641B11	5.65
TBA673	5.00
TBA700	3.95
TBA700Q	2.25
TBA720	5.10
TBA720A	5.10
TBA720AQ	2.10
TBA750	2.40
TBA750Q	2.50
TBA800	0.90
TBA800Q	2.85
TBA810A	3.40
TBA810S	1.10
TBA820	0.80
TBA915	7.35
TBA920	3.00
TBA920Q	3.50
TBA950-2	5.40
TBA950-2X	5.04
TBA990	4.95
TBA990Q	3.75
TCA160	5.10
TCA270	3.00
TCA270B	3.60
TCA270Q	3.60
TCA270S	2.25
TCA270SQ	3.40
TCA800	5.40
TCA800Q	12.40
TCA830	3.10
TDA440	6.75
TDA1327	2.85
TDA1327B	2.85
TDA1330	1.60
741	0.25

BRIDGE RECTIFIERS

CURRENT	VOLTAGE	ORDER CODE	PRICE
1A	50V	B1/50	0.25
1A	100V	B1/100	0.26
1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.45
2A	200V	B2/200	0.55
2A	400V	B2/400	0.65
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.95
6A	50V	B6/50	0.95
6A	200V	B6/200	1.10
6A	400V	B6/400	1.20
10A	400V	B10/400	2.50
25A	50V	B25/50	4.00
25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

I. C. SOCKETS

NO. OF PINS	ORDER CODE	PRICE
8	D8	0.10
14	D14	0.11
16	D16	0.13
20	D20	0.30
22	D22	0.35
24	D24	0.40
28	D28	0.45
40	D40	0.60

PANEL METERS

Size 2" x 2" x 1⅜"; requires 1¾ cut-out.

F.S.D.	ORDER CODE	PRICE
1mA	M1	5.50
500mA	M500	5.50

THYRISTORS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
80mA	30V	TO18	SO8/30	0.22
80mA	60V	TO18	SO8/60	0.24
80mA	200V	TO18	SO8/200	0.25
1A	50V	TO220	S1/50	0.25
1A	100V	TO220	S1/100	0.26
1A	200V	TO220	S1/200	0.28
1A	400V	TO220	S1/400	0.35
3A	50V	TO220	S3/50	0.25
3A	100V	TO220	S3/100	0.26
3A	200V	TO220	S3/200	0.30
3A	400V	TO220	S3/400	0.40
4A	50V	TO220	S4/50	0.35
4A	100V	TO220	S4/100	0.40
4A	200V	TO220	S4/200	0.50
4A	400V	TO220	S4/400	0.55
5A	400V	TO220	S5/400	0.55
7A	50V	TO220	S7/50	0.45
7A	100V	TO220	S7/100	0.50
7A	200V	TO220	S7/200	0.55
7A	400V	TO220	S7/400	0.60
8A	400V	TO220	S8/400	0.70

TRIACS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
3A	100V	TO220	T3/100	0.75
3A	200V	TO220	T3/200	0.80
3A	400V	TO220	T3/400	0.85
6A	200V	TO220	T6/200	1.00
6A	400V	TO220	T6/400	1.05
8A	400V	TO220	T8/400	1.35
10A	400V	TO220	T10/400	1.40
15A	400V	TO220	T15/400	2.00

ORDERING

Orders despatched by return of post. Payment with order, please add 20p for p/p with orders under £5, otherwise carriage free. No other charges – just send prices shown. Enquiries: please send s.a.e. Government departments and educational institutions just send official order. Mail order only.
Export orders welcome.

TTL

7400	.12
7401	.12
7402	.12
7403	.12
7404	.13
7405	.13
7406	.29
7407	.29
7408	.14
7409	.14
7410	.13
7411	.18
7412	.21
7413	.25
7414	.54
7416	.27
7417	.27
7420	.13
7421	.28
7423	.25
7425	.22
7426	.25
7427	.25
7428	.34
7430	.13
7432	.24
7433	.32
7437	.24
7438	.24
7440	.13
7441	.52
7442	.55
7444	.90
7445	.70
7446	.70
7447	.66
7448	.60
7450	.13
7451	.13
7452	.13
7454	.13
7460	.13
7470	.28
7472	.22
7473	.26
7474	.20
7475	.28
7476	.13
7483	.75
7484	.90
7485	.90
7486	.26
7489	2.00
7490	.35
7491	.65
7492	.45
7493	.36
7494	.80
7495	.55
7496	.62
7497	2.40
74100	.95
74105	.40
74107	.28
74109	.45
74110	.46
74111	.70
74116	1.60
74118	.82
74119	1.30
74120	.82
74121	.26
74122	.40
74123	.55
74125	.45
74126	.46
74128	.62
74132	.70
74141	.58
74142	2.02
74143	2.02
74144	2.02
74145	.65
74147	1.35
74148	1.20
74150	1.00
74151	.60
74153	.60
74154	1.06
74155	.63
74156	.63
74157	.63
74158	1.70
74160	.80
74161	.80
74163	.80
74164	.90
74165	.90
74166	1.00
74167	2.70
74170	1.70
74172	4.00
74173	1.20
74174	.90
74175	.70
74176	.90
74177	.90
74178	1.20
74179	1.10
74180	.70
74181	1.95
74182	.75
74184	1.20
74185	1.20
74186	7.20
74188	5.40
74190	1.10
74191	1.00
74192	1.00
74193	1.10
74194	.92
74195	.85
74196	.92
74197	.92
74198	1.60
74199	1.50

CMOS

4000	.15
4001	.15
4002	.20
4006	.95
4007	.20
4008	.94
4009	.46
4010	.50
4011	.15
4012	.15
4013	.35
4014	.85
4015	.80
4016	.45
4017	.55
4018	.90
4019	.45
4020	.60
4021	.85
4022	.85
4023	.20
4024	.68
4025	.20
4026	1.35
4027	.35
4028	.70
4029	.90
4030	.50
4033	1.40
4035	1.10
4040	.90
4041	.80
4042	.75
4043	.85
4044	.85
4049	.28
4050	.45
4051	.88
4052	.88
4053	.88
4055	1.00
4060	1.00
4066	.35
4068	.20
4069	.20
4070	.20
4072	.20
4073	.20
4075	.20
4076	1.10
4078	.20
4081	.20
4082	.20
4502	.90
4507	.52
4508	2.30
4510	1.10
4511	.70
4512	.95
4516	.70
4518	.65
4520	1.10

RESISTORS

¼W Values available in E12 series from 10R to 1M. **Price 0.03 each.**
½W Values available in E 12 series from 1R0 to 10M. **Price 0.03 each.**
1W Values available in E12 series from 2R2 to 10M. **Price 0.06 each.**
2W Values available in E12 series from 10R to 10M. **Price 0.11 each.**
5W Values available in E6 series from 1R0 to 6K8.
Prices 1R0 to 1K0 **0.19 each.**
1K5 to 3K3 **0.22 each.**
4K7 to 6K8 **0.24 each.**
7W Values available in E12 series from R47 to 22K.
Prices R47 to R82 **0.25 each.**
1R0 to 1K0 **0.26 each.**
1K2 to 12K **0.27 each.**
15K to 22K **0.28 each.**
11W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 1K0 **0.29 each.**
1K5 to 12K **0.30 each.**
15K to 22K **0.35 each.**
17W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 4K7 **0.39 each.**
6K8 to 22K **0.41 each.**

½W Single turn cermet potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M.
Price 0.97 each.

¾W Multiturn cermet potentiometer. Values available 20R, 50R, 100R, 200R, 500R, 1K0 2K0, 5K0, 10K, 20K, 100K, 500K.
Price 1.40 each.

1W Potentiometer with 2" spindle. Values available 10R, 25R, 50R, 100R, 250R, 500R, 1K0, 2K5, 5K0, 10K, 20K.
Prices 10R to 5K0 **1.51 each.**
10K & 20K **1.62 each.**

1.5W Convergence preset potentiometer. Values available 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.50 each.

2W 10 Turn potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

CAPACITORS

Tantalum Bead		
6.3V	47uF	**0.32 each**
	100uF	**0.50 each**
16V	10uF	**0.24 each**
	22uF	**0.30 each**
	47uF	**0.50 each**
25V	22uF	**0.41 each**
35V	0.1uF	**0.22 each**
	0.22uF	**0.22 each**
	0.47uF	**0.22 each**
	1.0uF	**0.22 each**
	2.2uF	**0.22 each**
	4.7uF	**0.24 each**
Disc Ceramic		
8kV	150pF	**0.27 each**
	180pF	**0.27 each**
	200pF	**0.27 each**
	220pF	**0.27 each**
	250pF	**0.40 each**
	270pF	**0.40 each**
	300pF	**0.40 each**
Mixed Dielectric		
600V	1uF	**1.01 each**
1kV	0.01uF	**0.26 each**
	0.033uF	**0.32 each**
	0.047uF	**0.35 each**
	0.1uF	**0.39 each**
	0.22uF	**0.58 each**
	0.47uF	**0.89 each**
1.25kV	0.1uF	**0.50 each**
1.5kV	0.001uF	**0.24 each**
	0.0022uF	**0.24 each**
	0.0047uF	**0.24 each**
	0.22uF	**0.28 each**
Single Ended Electrolytic		
16V	10uF	**0.11 each**
	22uF	**0.11 each**
	47uF	**0.11 each**
	100uF	**0.11 each**
	220uF	**0.14 each**
	470uF	**0.28 each**
	1000uF	**0.32 each**
63V	1uF	**0.11 each**
	2.2uF	**0.11 each**
	4.7uF	**0.11 each**
	10uF	**0.13 each**
	22uF	**0.16 each**
	47uF	**0.22 each**
	100uF	**0.32 each**
	220uF	**0.46 each**
Double Ended Electrolytic		
10V	22uF	**0.14 each**
	100uF	**0.14 each**
	220uF	**0.17 each**
	470uF	**0.36 each**
	1000uF	**0.40 each**
25V	10uF	**0.14 each**
	22uF	**0.14 each**
	47uF	**0.17 each**
	100uF	**0.17 each**
	220uF	**0.36 each**
	470uF	**0.47 each**
	1000uF	**0.72 each**
63V	1uF	**0.14 each**
	2.2uF	**0.14 each**
	4.7uF	**0.14 each**
	10uF	**0.17 each**
	22uF	**0.17 each**
	47uF	**0.29 each**
	100uF	**0.40 each**
	220uF	**0.65 each**
	470uF	**0.66 each**
	1000uF	**1.01 each**
	2200uF	**1.44 each**
100V	10uF	**0.20 each**
	22uF	**0.25 each**
	47uF	**0.36 each**
	100uF	**0.61 each**
	220uF	**0.68 each**
450V	1uF	**0.27 each**
	4.7uF	**0.45 each**
	10uF	**0.53 each**
	22uF	**1.07 each**
	33uF	**1.22 each**
Silvered Mica		
500V	3.3pF	**0.18 each**
	5pF	**0.18 each**
	10pF	**0.18 each**
	39pF	**0.18 each**
	100pF	**0.18 each**
	150pF	**0.18 each**
	180pF	**0.18 each**
	220pF	**0.18 each**
	330pF	**0.36 each**
	470pF	**0.36 each**
	680pF	**0.36 each**
	820pF	**0.36 each**
	1000pF	**0.42 each**
	2200pF	**0.50 each**
	8200pF	**1.58 each**
	10000pF	**1.62 each**
Multi-sectional Electrolytic		
30V	2500/2500uF	**1.94 each**
70V	2500/2500uF	**2.70 each**
300V	150/150/100uF	**2.81 each**
350V	200/300uF	**2.46 each**
	200/200/100/32uF	**3.89 each**
	150/100/100/100/150uF	**4.75 each**
	400/400uF	**4.75 each**
	300/300/150/100/50uF	**5.18 each**

NORMAN INSKIP

90, Charles Street,
Greenhithe, Kent.
Tel: Greenhithe (0322) 844985

HB
COMPUTERS LTD
Electronic Components Division

22 Newland Street Kettering Northants.
Technical enquires ring Kett 520910 sales & order enquires 83922.
Shop open Monday to Saturday 9.30 to 6.00 p.m. Early closing Thursday.
Answer phone order service after 6.00 p.m. 83922
Back issues of Elektor & Elektor Boards normaly available from stock.
Quantity and trade enquiries welcomed for all components.
Quantity and trade enquires welcomed for all components.
A Member Firm of the Brikat Developments (Holdings) Group

IC's

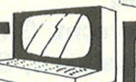
PRICE REDUCTIONS

CA3080	OTA	TO5	95
CA3084			300
CA3086	transistor array	14 dil	75
CA3090AQ	decoder	14 dil	575
CA3130T	opamp	TO5	120
CA3140T	FET opamp	TO5	120
ICM7038A	clock time base	8 dil	495
L129	5 V regulator	TO220	125
L130	12 V regulator	TO220	125
L131	15 V regulator	TO220	125
LF356	Bi Fet opamp	TO5	150
LD110CJ	digital DVM processor	16 dil	825
LD111CJ	analoque DVM		960
LM301AN	opamp	8 dil	70
LM308N	opamp	8 dil	130
LM311H	voltage comparator	TO5	150
LM317K	adjust reg.	TO3	400
LM311H	voltage comparator	TO5	255
LM318N	opamp	14 dil	310
LM324N	quad opamp	14 dil	98
LM325H	15 V regulator	TO5	360
LM326H	12 V regulator	TO5	360
LM327H	+ 5 – 12 V regulator	TO5	360
LM380N	audio amp	14 dil	140*
LM381N	dual audio pre amp	14 dil	220*
LM391	high power audio amp	16 dil	180*
LM555N	timer	8 dil	35
LM556N	dual timer	14 dil	85
LM556CN	vco	14 dil	170
LM567N	Pll tone decoder	8 dil	270
LM703LH	rf amp	TO5	100
LM709CN	opamp	8 dil	50
LM723CH	voltage regulator	TO5	75
LM723CN	voltage reg.	14 dil	85
LM741CN	opamp	8 dil	30
LM78L05	Voltage Reg	T092	38
LM78L05	Voltage Reg	T0220	95
LM78L012	Voltage Reg	T092	38
LM78L012	Voltage Reg	T0220	95
LM78L015	Voltage Reg	T092	38
LM78L015	Voltage Reg	T0220	95
LM1812N	ultra sonic transceiver	14 dil	720
LM1889	VHF Mod	18 dil	560
LM3900N	quad norton amp	14 dil	75
LM3909N	led flasher	8 dil	90
LM3911H	temp. transducer	TO5	180
M252	rhythm generator	16 dil	1175*
MC131OP	decoder	14 dil	220*
MC1312P	matrix SQ	14 dil	250*
MC1314P	vca SQ	16 dil	400*
MC1315P	logic control SQ	16 dil	600*
MC1458CP1	dual opamp	14 dil	90
MC1468L	dual regulator	14 dil	420
MC14440L	watch	40 dil	1393
MC1440Z	watch	flat pack	1600
MC14543CP	LCD driver	16 dil	147
MC14553P	3 digit counter	16 dil	396
MC14566P	time base	16 dil	132
MM2112	1K ram	16 dil	295
MM5204Q	EPROM	16 dil	POA
MM5314N	clock MPX 7 seg	24 dil	450
MM5316N	clokc non MPZ 7 seg	40 dil	550
MM5318N	clock BCD + address		740
MM5817	Noise generator		450
MM5841N	TV display driver	28 dil	1350*
RG4194TC	dual regulator	TO66	895
RC4151DN	V to F convertor	8 dil	750
SBV566	hall switch		120
SCMP1	ISP8A500D	40 dil	1250
SCMP2	ISP8A600N	40 dil	1000
SL440	Triac phase control	14 dil	450
SN76013N	audio	16 dil	180*
SN76131N	audio	14 dil	195*
SO41P	mixer	14 dil	195
SO42P	mixer	14 dil	195
STK025	Audio power IC		725*
STK032	Audio power IC		920
TAA550A	regulator	TO18	55
TAA861	opamp	TO5	155
TBA120	mixer	14 dil	95
TBA120T	IF	14 dil	95
TBA231	dual audio pre amp	14 dil	200*
TBA625A	5 V 100 mA regulator	TO5	110
TBA625B	12 V 100 mA regulator	TO5	110
TBA625C	15 V 100 mA regulator	TO5	110
TBA800SW	audio amp	16 quil	205*
TBA810S	audio amp		270*
TCA220	Triple opamp	16 dil	450
TCA280A			235
TCA740	DC tone	16 dil	530*
TDA1022	analogue shift register	16 dil	935
TDA1024	Triac Control 8 pin DIL		1.40
TDA2002	5 W 12 V audio amp		475
TDA2020	20W audio amp	14 quil	550*
U112B	triac control	14 dil	375
U113B	remote switch	4 dil	150
UAA170	led driver	16 dil	220
UAA180	led driver	18 dil	230
UA78G	regulator	TO220	235
UA79G	regulator	TO3	250
XR2206CP	function generator	16 dil	890
XR2207CP	VCO	14 dil	490
XR4212	Quad op amp	14 dil	250

LOW COST CMOS

4000	.16	4044	.93	4440	13.93
4001	.16	4046	1.23	4450	3.22
4002	.16	4049	.39	4450	3.22
4006	1.00	4050	.39	4490	7.83
4007	.16	4051	.39	4501	.16
4008	.91	4052	.85	4502	.81
4011	.16	4053	.85	4503	.67
4012	.16	4066	.85	4507	.34
4013	.39	4068	.57	4508	2.27
4014	.94	4069	.16	4510	1.14
4015	.94	4070	.16	4511	1.42
4016	.93	4071	.16	4512	1.05
4017	.94	4072	.16	4516	1.14
4018	.94	4073	.16	4517	3.37
4020	1.04	4075	.16	4521	1.78
4021	.94	4076	1.21	4522	1.31
4022	.85	4077	.16	4526	1.11
4023	.16	4078	.16	4527	1.49
4024	.69	4081	.16	4528	.98
4025	.16	4082	.16	4529	.08
4027	.46	4093	.57	4530	.64
4028	.84	4160	1.08	4536	3.30
4032	.94	4161	1.08	4541	1.27
4035	1.02	4162	1.08	4543	1.47
4038	.99	4163	1.08	4553	3.96
4040	1.03	4174	.98	4557	3.81
4042	.69	4175	.90	4566	1.32
4043	.93	4194	1.07	4583	.70
				4584	.56

EXPERIMENTING WITH SC/MP



BUILD YOUR OWN MICROPROCESSOR DEVELOPMENT SYSTEM

The current Elektor series leads to the construction of a hexadecimal seven segment microcomputer with a cassette interface. Further development is planned, to produce a private computor system with visual display unit, cassette based programmes and an extended memory capacity.
To enable you to reduce your costs we are preparing a kit order list for each part of the series to enable you to order just those parts you need and not to duplicate components you already have.
Please send SAE for lists or phone Kettering 520910 for further details about the series.

HB Announce new lower prices on many products and a wide range of money saving bulk offers. Send SAE for full list. All components FULL SPEC.

BC107/8/9	85p/10
BC547/8/9	75p/10
BC557/8/9	75p/10
BC516/517	2.80/10
BC212/3/4	75p/10
IN4001/2/3	48p/10
1N4004/5	55p/10
1N4007	70p/10
1N4148	2.20/100
Red LED 0.2	95p/10
Red LED .125	95p/10
Yellow/Green 0.2	1.20/10
Yellow/Green .125	1.00/10
DL707	3.50/4
LM741 op amp 8 pin DIL	1.80/10
LM555 timer	2.60/10
LM324	7.00/10
8 pin DIL socket	1.00/10
14 pin DIL socket	1.10/10
16 pin DIL socket	1.20/10

74 SERIES TTL

PRICE REDUCTIONS

7400	12	7416	28	7439	30	7472	26	7493	44	74128	62	74156	70	74177	85
7401	12	7417	28	7440	18	7473	30	7494	80	74132	60	74157	70	74180	85
7402	14	7420	15	7441	52	7474	28	7495	60	74136	75	74160	90	74181	220
7403	14	7421	40	7442	62	7475	45	7496	65	74137	80	74161	90	74182	80
7404	14	7422	20	7443	120	7476	32	74100	120	74141	70	74162	90	74185	150
7405	14	7423	25	7444	120	7480	48	74104	52	74142	290	74163	90	74189	320
7406	30	7424	30	7445	75	7481	115	74105	52	74143	290	74164	100	74190	120
7407	32	7425	26	7446	120	7482	85	74107	35	74144	290	74165	100	74191	120
7408	18	7426	26	7447	65	7483	75	74109	48	74145	65	74166	100	74192	95
7409	18	7427	26	7448	65	7484	120	74110	50	74147	150	74167	325	74193	98
7410	15	7428	40	7450	15	7485	80	74118	90	74148	140	74170	160	74194	95
7411	24	7430	15	7451	15	7486	30	74121	38	74150	100	74172	600	74195	75
7412	26	7432	26	7453	15	7489	220	74122	65	74151	62	74173	130	74196	95
7413	30	7433	47	7454	15	7490	38	74123	58	74153	55	74174	90	74197	92
7414	70	7437	26	7460	15	7491	76	74125	46	74154	80	74175	72	74198	150
7415	34	7438	26	7470	30	7492	44	74126	46	74155	70	74176	85	74199	160

HARDWARE & EQUIPMENT

Edge connectors 64 way (SC/MP)	(pair) 7.00
Edge connectors 31 way (format)	(pair) 3.00
Edge connectors 31 way (test pattern gen)	(pair) 1.50

SWITCHES
ROTARY

1 pole 12 way	54
2 pole 6 way	54
3 pole 4 way	54
4 pole 3 way	54

SLIDE

2 pole 2 way	18

MINIATURE TOGGLE

1 pole 1 way	65
1 pole 2 way	65
2 pole 1 way	65
2 pole 2 way	75
2 pole 2 way c/off	75
2 pole 2 way biased	80
2 pole 2 way locking	80
2 pole 2 way c/off	130

MINIATURE PUSH

1 pole 1 way non latching	15
1 pole 1 way latching	55
1 pole 2 way latching	60
2 pole 2 way latching	90
4 pole 1 way non latching	45

TRANSISTOR SOCKET; TO18; TO5 10 each

SILVER PLATED COPPER WIRE

18 swg	60/mtr
22 swg	50/mtr
24 swg	45/mtr

DIL SOCKETS

8 pin	12
14 pin	14
16 pin	16
24 pin	45
40 pin	65

LOUDSPEAKERS

64 ohm 2.5 ins	75*
8 ohm 2.5 ins	60*

VEROBOARD 0.1 inch

2.5 x 3.75 inch	42
2.5 x 5 inch	50
3.75 x 5 inch	56
V-O board 01-0044C	91

ANTEX SOLDERING IRONS

C2 15W light duty version	380
CX 15/18 18W ceramic shaft	380
X25 25W standard version	340
ST3 Soldering Irons Stand, complete with sponge	140
Spare bits for all above ANTEX Irons	48
Spare elements for C2	145
for CCN/R	190
For X25	160

S	Dec	1.98
u	Dec A	3.99
T	Dec	3.64

CATALOGUE '78

Catalogue 78 available now.

A must for serious constructors. Contains details of many unusual and difficult to obtain components for Elektor projects plus pages and pages of data information pin outs etc.
Normal price 75p but as special introductory offer for Elektor readers for limited period 50p.
plus 18p P & P

50p

CAPACITORS

MKM METALLISED POLYCARBONATE
7.5 mm radial leads – direct fit for many EPS boards.
Tolerance: + 10% up to 8n2 + 5% 10n and above
max. wkg. voltage: 250 V DC up to 47n 100 V DC 56n and above.

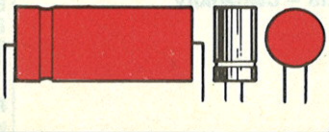
		individual price
1000 pF	1n0	5*
1500 pF	1n5	5*
2200 pF	2n2	5*
3300 pF	3n3	5*
4700 pF	4n7	5*
6800 pF	6n8	5*
8200 pF	8n2	6*
0.01 uF	10n	6*
0.012 uF	12n	6*
0.015 uF	15n	6*
0.018 uF	18n	6*
0.022 uF	22n	6*
0.027 uF	27n	6*
0.033 uF	33n	6*
0.039 uF	39n	6*
0.047 uF	47n	7*
0.056 uF	56n	7*
0.068 uF	68n	7*
0.082 uF	82n	7*
0.1 uF	100n	7*
0.12 uF	120n	8*
o.15 uF	150n	8*
o.18 uF	180n	10*
0.22 uF	220n	10*
o.27 uF	270n	12*
0.33 uF	330n	14*
0.39 uF	390n	16*
0.47 uF	470n	16*
0.56 uF	560n	20*
0.68 uF	680n	20*
1.0 uF (100mm pitch)		25*

CERAMIC
Close tolerance high stability sub-miniature plate capacitors. 63 V dc. E6 series values.

1 pF to 8.2 pF	4*
10 pF to 82 pF	5*
100 pF to 820 pF	7*

ELECTROLYTIC CAPACITORS

uF	V 6.3	10	16	25	35	63
0.47;1.0;1.5						8*
2.2						8*
3.3					8*	9*
4.7				8*	9*	9*
10			8*	8*	9*	12*
15		8*	9*	9*	11*	15*
22	8*	8*	8*	9*	11*	15*
33	8*	9*	9*	11*	12*	16*
47	9*	9*	10*	12*	15*	22*
100	10*	12*	12*	16*	20*	36*
220	12*	14*	16*	21*	27*	50*
330	15*	17*	18*	24*	33*	70*
470	16*	19*	21*	31*	39*	90*
1000	21*	24*	33*	46*	72*	110*
2200	33*	40*	52*	79*	122*	150*
4700	42*	54*	97*	120*	150*	185*

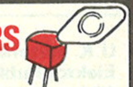


CRYSTALS, FILTERS & INDUCTORS

32.768	kHz	KDT-3	3.20	CERAMIC	
32.768	kHz	MTQ 32-12	6.00	FILTERS	
1.0	MHz	HC 33/U	4.50	SFE 6.0 MA	60
2	MHz	HC 33/U	4.50		
3.2768	MHz	HC 33/U	4.50	SFE 10.7	70
4.19304	MHz	HC 33/U	4.50	CFT 455B	70
4.7	MHz	HC 33/U	4.50	SFD 455B	70
6.364068	MHz	HC 33/U	4.50	CDA 10.7 MA	150
10.25	MHz	HC 18/U	3.00	TV Crystal	
27	MHz	HC 25/U	2.15	4.433619 MHz	
39	MHz	HC 25/U	2.15		2.00

Fixed inducers for PC mounting values
E12 0.1 uH to 100 mH. Ring or write for details.

TRANSISTORS & DIODES



For full list send SAE or see our Catalogue 78

AF239	50	BD139	40*	TIP29A	35*
BA127	11	BD140	45*	TIP31A	40*
BB104	60*	BD240	70	TIP41A	60
BB105	37*	BD241A	70	TIP42A	70
BB106	55*	BD242	75	TIS43	35
BB109	49*	BF194	09*	IN4001	05
BC107	10	BF195	09*	1N4002	05
BC108	10	BF199	15	1N4003	06
BC109	10	BF200	30	1N4004	06
BC140	42	BF225	20	1N4005	07
BC160	35	BF244	30	1N4006	07
BC177	18	BF245	28	1N4007	07
BC182L	10*	BF245c	30	1N4148	05
BC184L	10*	BF254	18	2N2219	25
BC212L	10*	BF494	45	2N3054	50
BC214L	10*	BF495	45	2N3055	50
BC516	30	BFX29	25	2N3702	09
BC517	35	BFY50	19	2N3703	09
BC547	10*	BFY51	19	2N3704	09
BC547b	12*	BFY52	19	2N3705	09
BC548	10*	BFY90	85	2N3819	18
BC549	10*	BRY39	35	2N5777	65
BC549b	12*	BRY56	45	40603	80
BC549c	13*	BY127	10	Zener Diodes 1W	
BC557	12*	BY164	70	3.3v to	
BC557b	15*	BY187	1.35	Zener Diodes	
BC558	12*	E100	40	400mW 2.7v to 47v	
BC559	12*	E300	45	E12 Series	12*
BC559b	15*	E310	60	Bridge rectifiers	
BC559c	16*	E420	1.60	for Elektor projects	
BCY70	19	E430	1.45	B 40C800W	40
BCY71	20	MJE340	80	B 40C5000	60
BD131	45*	MJE341	65	B250C1000	70
BD132	45*	MJE2955	1.40	B250C22001	50
BD138	53*	MJE3055	1.20		

Visit our new computer showroom.
Where our sister company, HB computers will be demonstrating the PET 2001, now in stock.

MICROPROCESSORS & PERIFI

Micro's and Memories
Send SAE for lists of development kits etc.

1103A-2	5.25
CDP1802 MPU	16.50
MC1488 RS 232 Interface	1.40
MC1489 RS 232 Interface	1.40
MM1702A EPROM 256 x 8	4.98
MM2102AN RAM 1k x 1	1.50
MM2107B	4.50
MM2112 RAM 256 x 4	2.95
MM2708 EPROM 1k x 8	10.50
271AJ EPROM 2k x 8	21.00
MM5204 (Blank) EPROM 512 x 8	10.50
SC/MP 1SP8A 500D MPU	12.50
SC/MP 1SP 8A 600D MPU	10.50
COSMAC vid computer on a card with built in PSU sound effects gen ans TV interface. Complete with HEX keypad, monitor in ROM + 2048 byte of RAM	£230

OPTOELECTRONICS

PRICE REDUCTIONS

Display	drive	decimal point	size	mounting	digits	price
DL704	CC	RDP	0.3"	14 dil	single	1.20
DL707	CA	LDP	0.3"	14 dil	single	1.20
DL727	CA	RDP	0.5"	18 dil	dual	1.95
DL728	CC	RDP	0.5"	18 dil	dual	2.20
DL747	CA	LDP	0.63"	18 dil	single	2.20
DL750	CC	LDP	0.63"	18 dil	single	2.20
FND500					single	1.65
HP7730	CA	LOP	0.3"	14 dil	single	1.80
HP7732	CA	LDP	0.3"	14 dil	1	2.30
HP7750						1.80

BPW 34	photo diode	2.60
IL 74	opto isolator	1.10
IRL 60	infra red led	.70
LD 241	infra red transmitter	2.40
2N5777	photo darlington	.65
ORP 12	light dependent resistor	.80
Wire ended neon		.20
LED red o.2"		.15
LED red 0.125"		.12
LED green; yellow; clear 0.2"		.22
LED green, yellow; 0.125"		.22

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VAT add high rate to *items, standard rate to others
POST & PACKING 50 p on orders under £7.50. Otherwise free. Overseas please add freight costs and state surface or Air.
DELIVERY. All orders processed on day of receipt. All goods offered subject to availability and our conditions of sale.
PAYMENT. Cash, cheque or postal order with order. Access, Mastercharge, Bank Americard visa or Barclaycard number by phone or letter for orders over £2 Official orders from Government bodies, accepted, but minimum invoice charge £2.50.
GUARANTEE. All devices are brand new and full spec. unless otherwise stated. Any faulty item returned in good condition within fourteen days will be exchanged or refunded.
BACK copies of Elektor and Elektor EPS circuit boards available at published prices.

PRICES valid at the time of going to press

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elektor 43

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For technical queries, please enclose a stamped, addressed envelope or a self-addressed envelope plus an IRC.

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ABC
MEMBER OF THE AUDIT BUREAU OF CIRCULATIONS

decoder

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA741, LM741, MC641, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

U_{CEO}, max	20V
I_C, max	100 mA
h_{fe}, min	100
P_{tot}, max	100 mW
f_T, min	100 MHz

Some **'TUN'**s are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP'**s are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
U_R, max	25V	20V
I_F, max	100mA	35mA
I_R, max	1μA	100 μA
P_{tot}, max	250mW	250mW
C_D, max	5pF	10pF

Some **'DUS'**s are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG'**s are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistor and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:

p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4.7 pF, or 0.000 000 000 004 7 F . . .
Capacitance value 10n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbon types, unless otherwise specified.
The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC supply voltage.

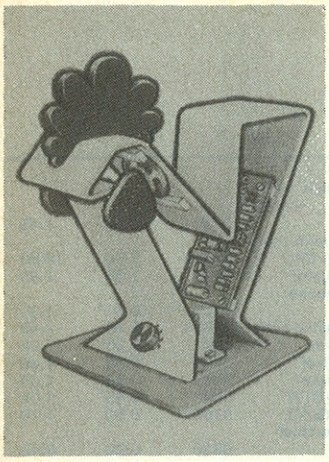
Test voltages
The DC test voltages shown are measured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: U_b = 10 V, not V_b = 10 V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

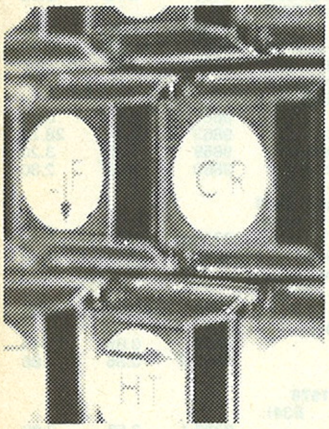
Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service list' in the current issue always gives a complete list of available boards.
- **Technical queries.** Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements on or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.



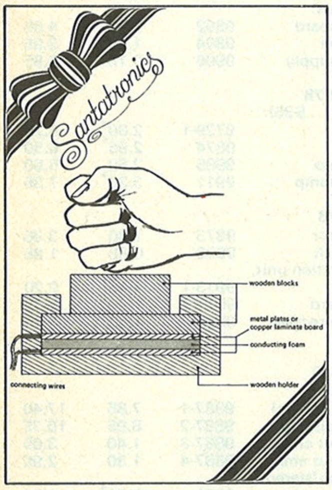
After several experiments, one of our designers succeeded in imitating the sound of a self satisfied hen — using a single CMOS IC. A simple timer completes the **cackling egg-timer.**

p. 11-02



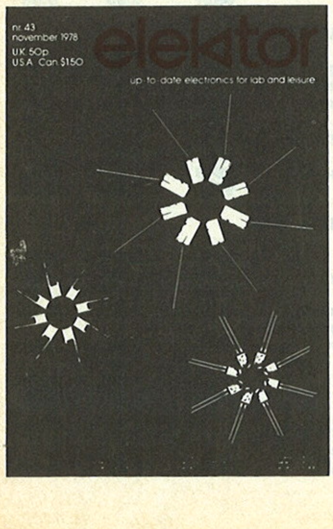
The most common method of communicating with a microcomputer is via an alphanumeric keyboard. The **ASCII keyboard** is principally intended for use with the 'Elekterminal', which will be described next month, however the standard design ensures that it can also be employed with other data terminals.

p. 11-06



One of the favourite attractions at fair-grounds has always been some variation of **'ring the bell and win a prize'.** Originally, this was a purely mechanical device. However, electronics have now progressed to the point where a portable version is possible — suitable for desk-top use.

p. 11-22



In this issue, several 'Santatronics' circuits are described: little projects that should prove suitable as Christmas gifts. November may seem rather soon for this, but the idea is to allow time for neat construction and 'gift-wrapping'! As to the cover, 'Santatronics' is associated both with electronics and with 'Dashing through the snow' . . .

contents

selektor **UK-16**

cackling egg-timer **11-02**

ASCII keyboard **11-06**

Tag! **11-12**

This strenuous game can now be played without physical effort.

joysticks — G. Wünsch **11-16**

Joystick-type controls are becoming as popular in the electronic game field as they have always been for remote control of model aircraft and boats. Provided the appearance isn't considered too important, it is quite feasable to construct a joystick control that will be quite suitable for most applications.

digiscope — E. Müller **11-17**

For examining pulse trains in digital circuits an oscilloscope is an invaluable aid. However, oscilloscopes are expensive, and furthermore the analogue display capability of a conventional 'scope is rarely required in digital circuits. The Digiscope offers a low-cost alternative.

ring the bell and win a prize **11-22**

extending the TV scope **11-25**

As explained last month, a normal TV set can be used as an oscilloscope. A simple converter for this purpose was described in detail: the 'TV scope-basic version'. In an introductory article it was explained that this basic version could be extended. Before discussing the details of the extension circuits, a fuller explanation of the underlying principles is in order.

15 duty-cycles at the turn of a switch **11-30**

hello, all you folks back home! **11-31**

Instead of gathering around the fire as in the 'good old days', we tend to gather around the telephone. The circuit described will pick up the telephone conversation and reproduce it via a loudspeaker, so that several people can listen in.

applikator **11-34**

R.P.M. and dwell meter using a TCA 965.

SC/MP 'Mastermind' TM programme **11-35**

F. Schuldt

Pit your wits against the computer with the aid of the 'Mastermind' TM programme, which is designed to run on the Elektor SC/MP system.

pocket bagatelle **11-38**

There are many electronic versions of popular games which can be played without recourse to a TV set. One of the more simple (but not necessarily easy!) games, which is ideally suited as a small Christmas present, is 'bagatelle'.

market **11-41**

advertiser's index **UK-28**

COMING SOON

In response to readers queries, the additional circuits required to extend the range of the electronic piano (Elektor, September 1978) to eight octaves (!) will be described next month.

eps printservice

Many Elektor circuits are accompanied by designs for printed circuits. For those who do not feel inclined to etch their own printed circuit boards, for their own use only, a number of these designs are available as ready etched and pre-drilled boards. Delivery time is approximately three weeks, U.K./air mail.
Payment must be in advance.

1. For U.K. and all countries except the U.S.A.:
Payment, incl. £ 0.15 post & packing , to:
Midland Bank Ltd., Canterbury, A/C no. 11014587,
Sorting code 40-16-11.
Please make your cheque payable to
Elektor Publishers Ltd., Canterbury, England.

2. For the U.S.A. only:
Please make your cheque/money order payable to
Elektor Publishers Ltd., Bank of America, c/o World
Way Postal Center, P.O. Box 80689, Los Angeles,
Cal. 90080, A/C no. 12350-04207.

Prices include post & packing, surface mail. If air mail, please add $ 0.50.

Example:

$$\underset{1}{\text{digisplay}}\qquad\underbrace{\text{(E13)}}_{2}\quad\underbrace{9376}_{3}\underset{4}{\downarrow}\quad\underbrace{3.10}_{5}\underset{6}{\downarrow}\;\underbrace{6.90}_{7}$$

1. Circuit title
2. reference to associated article(s)
3. board number
4. * = p.c.b.'s without solder mask

U.K.:

5. price (in £) inclusive of VAT
6. $^+$ = 12.5% VAT; otherwise 8% VAT

U.S.A. and Canada:

7. price in $, not including tax (if any)

		£	$
E1: DECEMBER 1974			
equa amplifier	1499*	1.80$^+$	3.95
E3: APRIL 1975			
disc preamp 76131	4040A*	1.25	2.80
E7: NOVEMBER 1975			
ota pll	6029*	1.40$^+$	3.10
frequency counter, minitron display board	9312	1.45	3.20
frequency counter, led display board	9313	1.45	3.20
frequency counter, counter/latch/display driver	9314	1.20	2.60
E8: DECEMBER 1975			
die	9169	0.85	1.90
730/740 (IC control amplifier)	9191	1.40$^+$	3.10
E12: APRIL 1976			
stylus balance	9343	0.45$^+$	1.05
rhythm generator (M253AA)	9344-3	1.45$^+$	3.20
ic drummer, instruments mother board	9344-2	2.00$^+$	4.40
ic drummer, instruments daughter board	9344-1	0.35$^+$	0.80
UAA 170, 270° meter, basic board (E17)	9392-1	1.50	3.30
UAA 170, 270° meter, front panel (E17)	9392-2	2.00	4.40
UAA 170, LED voltmeter, basic board	9392-3	1.15	2.50
UAA 170, 16 LED display board	9392-4	0.95	2.10
E13: MAY 1976			
preco, preamplifier	9398	2.40$^+$	5.35
preco, control amplifier	9399	1.40$^+$	3.10
equin	9401	2.55$^+$	5.65
E17: SEPTEMBER 1976			
tachometer, LED meter board (E12)	9392-1	1.50	3.30
tachometer, front panel (E12)	9392-2	2.00	4.40
tachometer, control board	9460	1.45	3.15
windscreen wiper delay, using SCR	9474-1	0.70	1.55
E19: NOVEMBER 1976			
intercom	9156	1.05	2.30
albar: see E25, May 1977			
albar, power supply	9437	1.15	2.50
signal horn	9438	1.05	2.30
sensitive metal detector	9750	1.80	3.95
E20: DECEMBER 1976			
parking meter alarm	9491	0.90	2.00
E21: JANUARY 1977			
stereo audio mixer	9444	6.55$^+$	14.50
marbles	9753	1.55	3.40
E22: FEBRUARY 1977			
local radio AF	9499-1	0.70$^+$	1.55
local radio psu	9499-2	0.70	1.55
E23: MARCH 1977			
OTA-PLL (E7, E24)	6029	1.40$^+$	3.10
scope calibrator	9455	0.30	0.65
run rabbit, run!	9764	4.15	9.15
E24: APRIL 1977			
digisplay (E13)	9376	3.10	6.90
LED VU/PPM,			
rectifier section	9419-1	2.35$^+$	5.15
display section	9419-2	4.50$^+$	9.95
audio slide changer	9743	0.65	1.45
morse decoder	9759	7.35	16.25
signal injector	9765	0.50	1.10
E25: MAY 1977			
model car track (E24):			
multiplex encoder	9796-1	3.10	6.85
infra-red transmitter	9796-2	1.60	3.55
albar (E19):			
single transducer/receiver	9815-1	1.25	2.80
transmitter	9815-2	0.40	0.85
E26: JUNE 1977			
precision timebase	9448	1.55	3.40
power supply for precision timebase	9448-1	0.60	1.30
formant: keyboard interface (E25)	9721-1	2.60$^+$	5.75
levitator	9763	2.35	5.20
active loudspeaker cross-over filters (E25)	9786	1.95$^+$	4.30
model car track (E24,E25):			
servo amplifier	9803	0.35	0.80
E27/E28: SUMMER CIRCUITS 1977			
knotted handkerchief	9830	0.20	0.45
distortion meter	77005	1.85$^+$	4.10
guitar preamp	77020	1.10$^+$	2.45
0 . . . 10 V supply	77059	0.95	2.10
π-qualiser	77071	0.70$^+$	1.50
automatic NiCad charger	77075	0.65	1.45
TV games	77084	2.05	4.50
4 W car radio amplifier	77101	0.65$^+$	1.40
3½ digit DVM	77109	2.15	4.70
E29: SEPTEMBER 1977			
FM mains intercom	9359	4.85	10.75
formant (E25, E26):			
interface receiver	9721-2	1.30$^+$	2.80
power supply	9721-3	4.15$^+$	9.15
keyboard divider (one octave)	9721-4	0.75$^+$	1.70
logarithmic darkroom timer	9797	1.50	3.35
CCIR test pattern generator, motherboard	9800-1	5.95	13.10
model car track (E24 . . . E26):			
motor speed control	9829-1	0.55	1.20
proptester	9829-2	1.55	3.45
E30: OCTOBER 1977			
CCIR			
daughter board 1 (E29)	9800-2	3.30	7.35
infrared transmitter	9822	2.50$^+$	5.55
Kirlian camera (two boards)	4523 9831	2.25	5.00
model car track (E24 . . . 26, 29):			
infrared receiver	9848-1	0.80	1.80
multiplex decoder	9848-2	0.85	1.90
E31: NOVEMBER 1977			
formant (E25 . . . E30):			
VCO	9723-1	8.30$^+$	18.35
CCIR: daughter board 2 (E29, E30)	9800-3	2.55	5.65
video biofeedback:			
display generator	9825-1	2.55	5.60
alpha amplifier	9825-2	2.10	4.60
electrometer	9826-1	0.70	1.50
sensors for electrometer	9826-2	0.65	1.40
magnetiser	9827	0.65	1.45
experimenting with the SC/MP:			
RAM-I/O	9846-1	5.75	12.70
SC/MP board	9846-2	1.80	3.95
model car track (E24 . . . E30):			
transmitter power supply	9218	1.00	2.20
chassis	9850	2.85	6.35
E32: DECEMBER 1977			
formant (E25 . . . E31):			
VCF	9724-1	3.40$^+$	7.45
experimenting with the SC/MP (E31): CPU	9851a	8.50	18.80
UHF TV modulator	9864	1.35	2.95
electret microphone preamplifier	9866	0.60$^+$	1.30
analogue frequency meter	9869	1.10	2.40
heating controller	9877	3.20	7.05
MW reflex receiver	9880	0.85	1.85
sensitive lightmeter	9886	0.60	1.30
stylus balance (E12)	9343	0.45$^+$	1.05
signal injector (E24)	9765	0.50	1.10
knotted handkerchief (E27/E28)	9830	0.20	0.45
E33: JANUARY 1978			
simple function generator	9453	2.70	6.00
formant (E25 . . . E32):			
ADSR	9725-1	3.20	7.05
UAA 180 LED voltmeter	9817	1.75	3.90
elektor equaliser	9832	3.45$^+$	7.65
experimenting with the SC/MP (E31, E32):			
bus board	9857	3.00	6.65
memory card	9863	12.75	28.20
CMOS noise generator	9859	1.45	3.20
peak programme meter	9860	1.30$^+$	2.80
E34: FEBRUARY 1978			
formant (E25 . . . E33):			
DUAL-VCA	9726-1	3.35	7.40
development timer	9840	2.10	4.60
experimenting with the SC/MP (E31 . . . E33):			
HEX I/O	9893	17.00	37.60
infra-red light gate:			
transmitter	9862-1	0.65	1.40
receiver	9862-2	0.85	1.85
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	3.55	7.90
noise module	9728-1	3.05	6.75
4 k RAM card	9885	14.90	32.90
colour TV games:			
VHF games board	9892	2.10	4.65
UHF converter	9864	1.35	2.95
SC/MP power supply	9906	3.10	6.85
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	2.80$^+$	6.20
elektornado	9874	2.95$^+$	6.50
cassette interface	9905	2.50	5.50
moving coil preamp	9911	3.30$^+$	7.35
E37: MAY 1978			
colour modulator	9873	1.80	3.95
percolator switch	9902	0.85	1.85
digital reverberation unit,			
main board	9913-1	4.15$^+$	9.20
extension board	9913-2	1.20$^+$	2.60
mini shortwave receiver	9920	1.50$^+$	3.35
E38: JUNE 1978			
1/4 GHz counter			
timebase and control	9887-1	7.85	17.40
counter and display	9887-2	8.95	19.75
low freq. input amp	9887-3	1.40	3.05
high freq. input amp	9887-4	1.30	2.90
automatic mono/stereo switch	9923	0.90$^+$	2.00
TV sound modulator	9925	0.95	2.05
mini-counter	9927	2.50	5.50
E39/40: SUMMER CIRCUITS 1978			
power flasher	78003	0.80	1.75
electronic gong	78037	1.05	2.35
bicycle speedometer	78041	0.85	1.85
glowplug regulator	78042	1.75	3.90
touch dimmer	78065	0.75	1.65
micropower amplifier	9558	1.00	2.15
consonant	9945	6.40	14.10
luminant (3 boards)	9949	6.05	13.35
preconsonant	9954	2.00	4.40
E41: SEPTEMBER 1978			
piano			
octave	9914	3.15$^+$	7.00
power supply	9979	1.70$^+$	3.80
filter	9981	4.25$^+$	9.40
master tone generator	9915	7.55$^+$	16.70
temperature-controlled soldering iron	9952	1.60	3.55
formant			
24 dB VCF	9953-1	4.00$^+$	8.80
puffometer	9961	1.50	3.30
E42: OCTOBER 1978			
central alarm system:			
master station	9950-1	2.45	5.40

eps printservice

slave station	9950-2	2.15	4.75
alarm station	9950-3	1.05	2.35
resonance filter module	9951	3.70^{+}	8.25
VHF/UHF modulator	9967	1.35	2.95
TV-scope:			
Y-amplifier	9968-1	1.80	3.90
main board	9968-2	3.40	7.50
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sync circuit	9968-4	1.70	3.80
power supply	9968-5	1.35	2.95
databus buffer	9972	1.35	2.95
analogue reverberation unit	9973	4.85^{+}	10.65
proximity detector	9974	2.25	5.00

NEW

E43: NOVEMBER 1978

digiscope, main board	9926-1	4.80	10.65
digiscope, display board	9926-2	1.35	2.95
ASCII keyboard	9965	6.50	14.35
cackling egg-timer	9985	1.85	4.05
loudspeaking telephone,			
main board	9987-1	1.50	3.30
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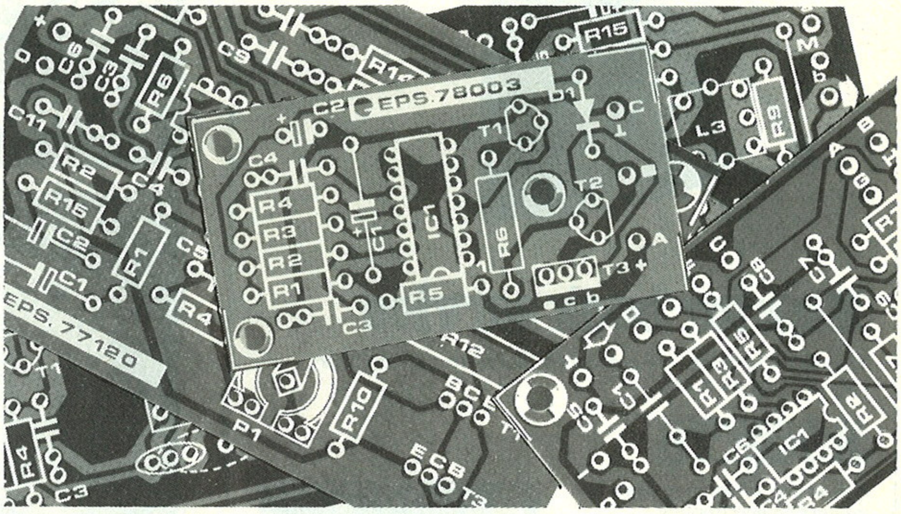

eps front panels

front panels for Formant (E25 . . . E35)

interface	9721-F	1.40	3.05
VCO	9723-F	1.40	3.05
VCF	9724-F	1.40	3.05
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consonant (E41)	9945-F	4.25^{+}	9.40

ess software service

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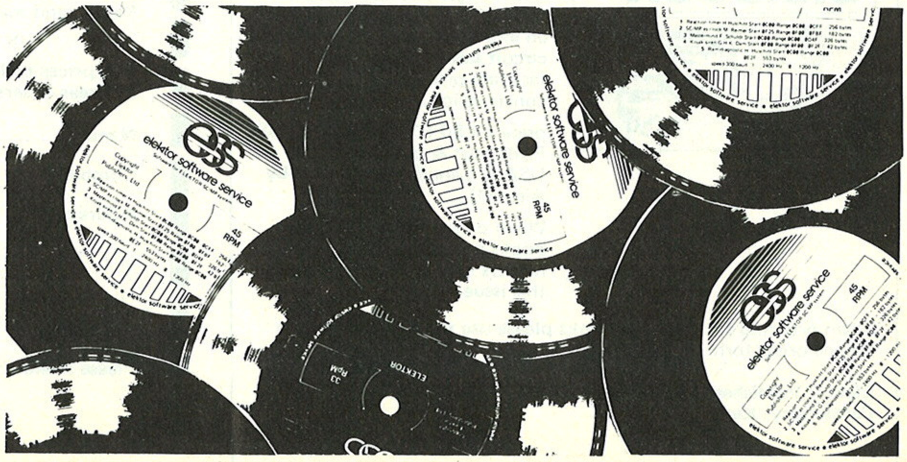

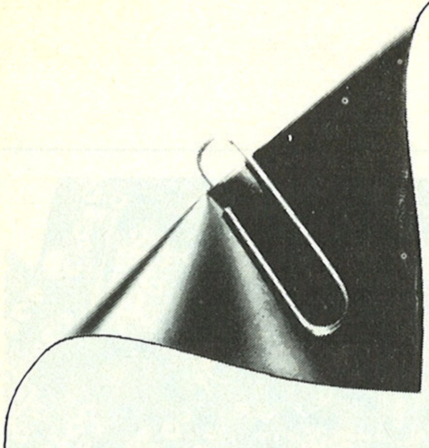

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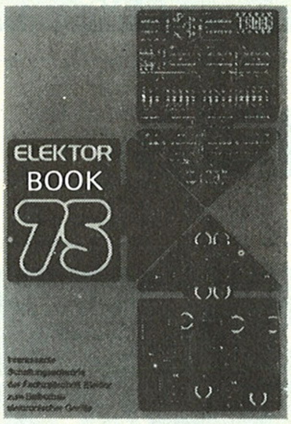

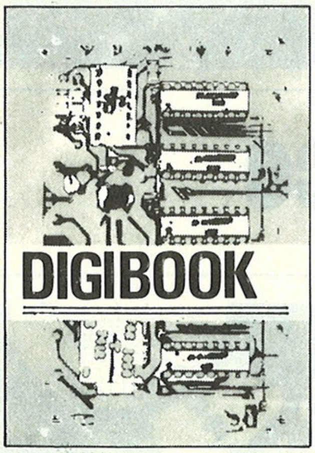

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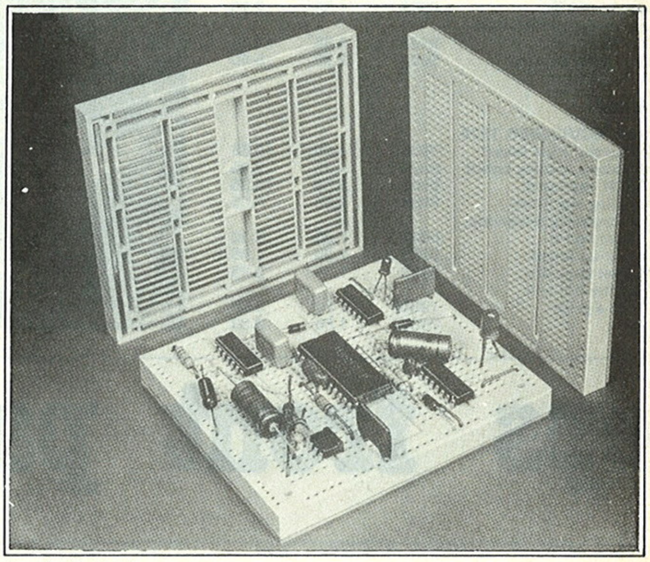

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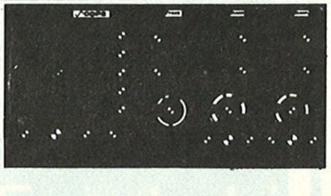

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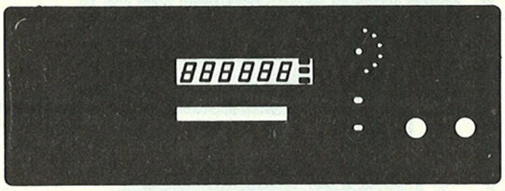

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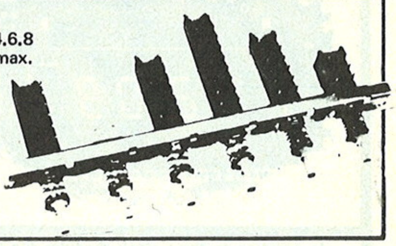

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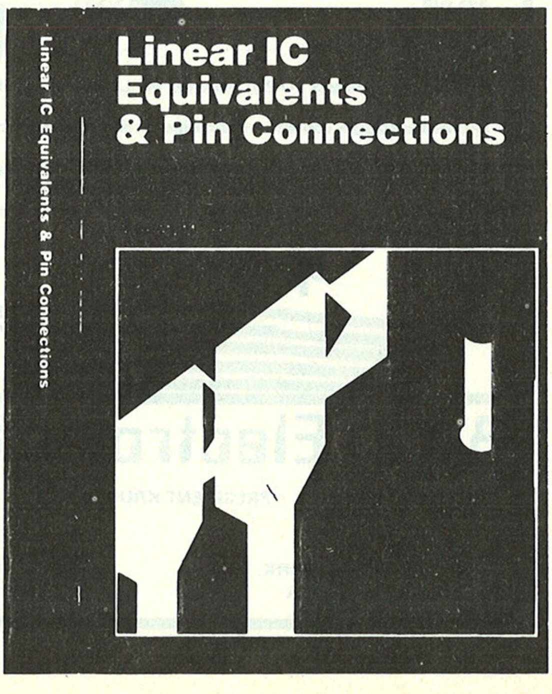
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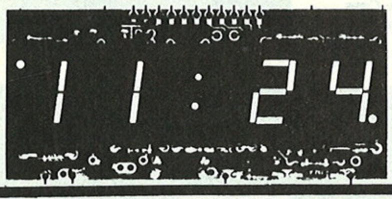

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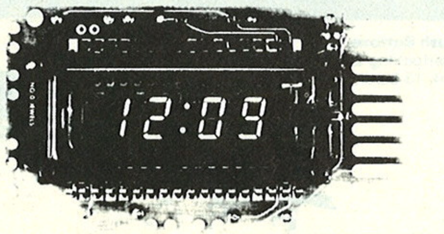

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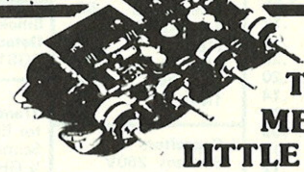

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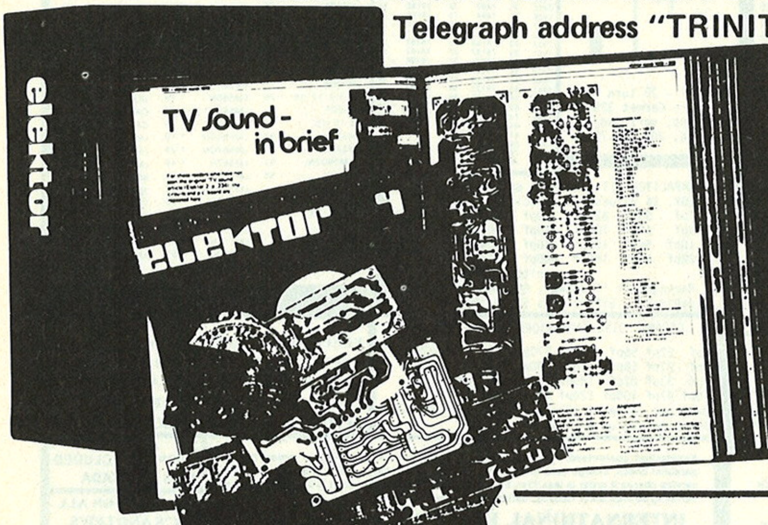

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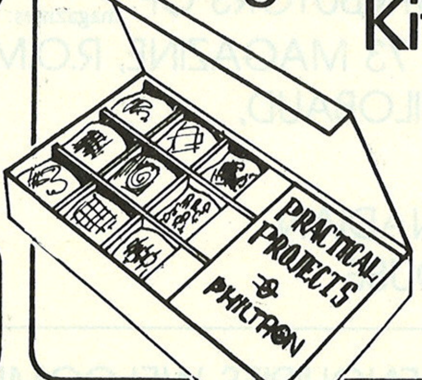

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MM5262	1K RAM	.95
F93410	256 bit RAM	.95
2708	8K EROM	$8.95
2510	Dual 50 bit Shift Reg.	.95
2511	Dual 100 bit Shift Reg.	.95
2518	Hex 32 bit Shift Reg.	1.25
2522	Dual 132 bit Shift Reg.	.95
MM5016	500/512 bit Shift Reg.	.95
SL-5-4025	Quad 25 bit Shift Reg.	.59
MM5314	Clock Chip	2.95
MM5316	Clock Chip	.95
MM5370	Clock Chip	3.95
MM5375AA	Clock Chip	2.95
CT7001	Clock Chip	4.95
301m	Prec. Op Amp	$.19
302H	Volt Follower	.39
308H	Prec Op Amp	.49
311N	Hi Perf V Comp.	.59
340T6v	Pos. V Reg.	.59
540H	Power Amp	1.59
565N	Genl Purp PLL	.99
723N	Volt Reg	.45
733H	Diff Video Amp	.49
739N	Dual Audio Preamp	.69
1414N	Dual Diff Comp.	.99

ELECTRONIC BUZZER

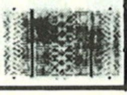
Miniature, Solid State
6V 15ma (4-9V oper.) $1.29 ea.
12V 15ma (8-20V oper.) $1.29 ea.

IC SOCKETS

Low Profile Solder Tail				Wire Wrap	
8 pin	$.16	24 pin	$.36	8 pin	.45
14 pin	.19	28 pin	.44	14 pin	.49
16 pin	.21	40 pin	.61	16 pin	.55
18 pin	.28				

UNIVERSAL BREADBOARD

Silver placed copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16"x5-1/16" $1.00



TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, ± 100 PPM/°C ± 20%
500 ohm, 2K, 10K, 25K, 50K, 100K, 500K, 1M. $.75 ea. .69/10-

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K $1.75 ea

TTL

7400	11	7451	20	74155	75
7401	18	7453	20	74156	75
7402	14	7454	20	74157	85
7403	14	7460	20	74158	1.39
7404	16	7464	35	74160	1.23
7405	19	7465	35	74161	95
7406	29	7470	38	74162	1.39
7407	28	7472	35	74163	95
7408	22	7473	35	74164	95
7409	17	7474	31	74165	95
7410	16	7475	49	74166	1.19
7411	25	7476	34	74170	1.90
7413	43	7483	68	74173	1.49
7414	65	7485	88	74174	1.19
7415	25	7486	38	74175	95
7416	35	7489	2.25	74176	84
7417	35	7490	43	74177	84
7420	16	7491	75	74180	95
7423	37	7492	48	74181	2.30
7425	35	7493	48	74182	85
7426	22	7494	75	74185	2.20
7427	35	7495	75	74190	1.25
7430	20	7496	75	74191	1.15
7432	23	74100	1.15	74192	89
7437	25	74107	37	74193	85
7438	25	74121	37	74194	1.15
7439	50	74122	38	74195	74
7440	15	74123	45	74196	98
7441	85	74125	54	74197	95
7442	59	74126	58	74198	1.69
7443	65	74132	75	74199	1.69
7444	73	74141	85	745200	3.95
7445	65	74145	90	74279	79
7446	81	74150	98		
7447	59	74151	68		
7448	79	74153	60		
7450	17	74154	1.20		

DIODES

Silicon SW diode assorted 400 mw	$.05ea
1N4148 (1N914) Silicon diode 400 mw	.10
1N3064 Silicon SW diode 400 mw	.10
1N4006 Silicon rect. diode 600V 400mw	.10
Zener diode 400 mw - 2.4V, 3.6V, 5.1V, 6.5V, 6.8V, 10V, 12V, 14.5, 15V, 120V	.15
Germanium diode 400 mw	.08

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	150/15	1.25
4.7/16	.25	15/20	.35		

LINEAR CIRCUITS

LM300H .	$ 71	LM372N	2 93	LM733H	79
LM301CN	29	LM376CN	59	LM739N	99
LM302H	65	LM380N	1 29	LM741CN(8)	32
LM304H	80	LM380-8CN	95	LM741CN(14)	32
LM307CN	26	LM381N	1 75	LM741CH	35
LM307H	30	LM382N	1 75	LM747H	79
LM308H	89	LM385K	45	LM747N	71
LM309H	1 05	NE531V	2 90	LM748CN	35
LM309K	99	NE540L	2 90	LM1310N	2 80
LM310CN	1 07	NE546A	1 09	LM1414N	1 59
LM311CN	89	NE550A	75	LM1456CN	1 29
LM311H	89	LM555CN	39	LM1458CN	59
LM311N	89	NE556A	85	LM1496N	89
LM319N	1 13	LM560N	2 95	LM1800N	2 48
LM320K		LM561N	2 95	ULN2208	89
5 5 2 12 15	1 29	LM565N	1 19	ULN2209	89
LM320T		LM565H	1 39	CA3046	1 19
5 12 15	1 19	LM566H	1 39	CA3081	1 49
LM322N	1 59	LM566CN	1 19	LM3900N	49
LM324N		LM567CN	1 29	LM7524	79
(LM2902N)	1 52	LM567H	1 49	LM7525	79
LM339N	1 58	LM703H	59	8038B	4 59
LM340K		LM703CN	39	75451CN	35
5 6 8 12		LM709N	25	75452CN	35
15 18 24	1 29	LM709H	29	75453CN	35
LM340T		LM710N	59	75454CN	35
5 6 8 12		LM711N	39	75491N	71
15 18 24		LM723H	55	75492N	85
(78 – – Equiv)	1 19	LM723N	52		

CAPACITOR KIT - ceramic disc
50V, 24 values, 10 capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95
Packeged in 15 drawer, 60 compartment cabinet....$19.95 plus $2.00 shipping

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± 1%, 1/4w, ± 50 PPM/°C
Standard Decade Values 10.5 - 464K

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100-999	.20	.10	$9.00/100
1000-			8.00/100

PRECISION RESISTOR PACKAGE
Metal Film ± 1% 1/4 watt
Starter Kit - 2ea. 60 values
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Supplied in 15 Drawer 60 Comp. Cabinet - $26.50 + $2.00 Sh.

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5pf	27pf	68pf	150pf	390pf	.001uf	.030uf
7pf	33pf	82pf	180pf	470pf	.0047uf	.050uf
10pf	47pf	100pf	220pf	600pf	.01uf	

0-10 per value..$.10ea 10-up per value $.05ea
10-up per value $.05ea

Carbon Film Fesistors ± 5% 1/4w, 1/2w

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.05	
100-999	.10	.04	$3.00/100
1000-			2.50/100

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LM325H	£ 3.02	TBA450N	£ 3.30
LM325N	£ 4.27	TBA460Q	£ 2.12
TCA33A	£ 0.97	TAA550	£ 0.31
LM339N	£ 0.84	TBA550Q	£ 2.45
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LF 356N	£ 1.23	NE556	£ 1.10
LF357N	£ 1.23	SAS560S	£ 2.30
LF358N	£ 0.71	LM565CN	£ 1.28
LM373N	£ 4.63	S566B	£ 3.42
LM377N	£ 2.21	LM566CN	£ 2.38
LM380N	£ 1.19	LM567CN	£ 2.60
LM381N	£ 1.79	SAS570S	£ 2.30
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IN4007	8p
IN4148	5p
IN5402	16p
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2N1132	24p
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2N1303	48p
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2N1307	56p
2N1308	60p
2N1309	60p
2N1599/SCR	88p
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2N1711	22p
2N1893	35p
2N2218	24p
2N2218A	24p
2N2219	24p
2N2219A	24p
2N2270	75p
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2N2924 •	25p
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2N2926 •	25p
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2N3663 •	52p
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2N3703 •	10p
2N3704 •	11p
2N3705 •	10p
2N3706 •	9p
2N3707 •	12p
2N3708 •	8p
2N3709 •	12p
2N3710 •	12p
2N3711 •	12p
2N3794 •	21p
2N3819 •	28p
2N3820 •	56p
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2N3904 •	24p
2N3906 •	28p
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2N5458 •	39p
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6F40	£1.46
16F40	£1.65
40HF10	£1.64
40HF40	£2.28
40250	95p
40361	38p
40362	35p
40406	40p
40408	40p
40412	56p
40594	£1.18
40595	£1.50
40602	75p
40636	£1.80
40673	86p
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AA113	9p
AA116	9p
AA117	9p
AA118	10p
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BC122Y	61p
BC125 •	20p
BC126 •	20p
BC140	43p
BC147A •	21p
BC147B •	21p
BC148A •	21p
BC148B •	21p
BC148C •	21p
BC148C •	21p
BC149C •	21p
BC154 •	16p
BC157A •	21p
BC157B •	21p
BC158B •	21p
BC159B •	21p
BC160	49p
BC167A •	8p
BC167B •	12p
BC168A •	8p
BC168B •	12p
BC168C •	8p
BC169B •	8p
BC169C •	12p
BC177A	18p
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BC213 •	12p

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BC257B •	8p
BC258A •	8p
BC258B •	8p
BC259B •	8p
BC267	16p
BC268C	17p
BC269C	18p
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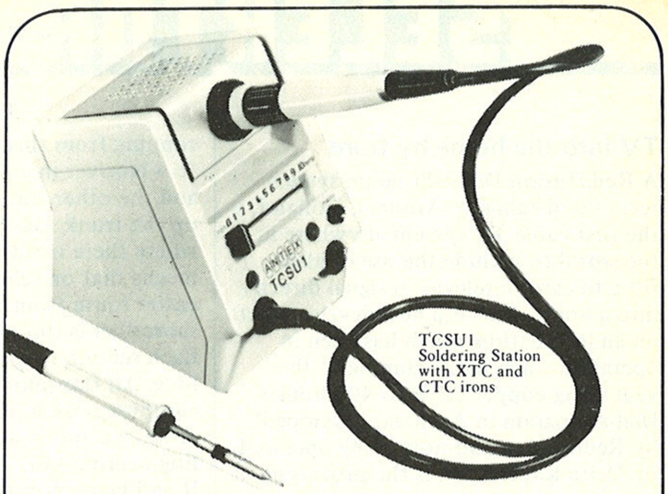

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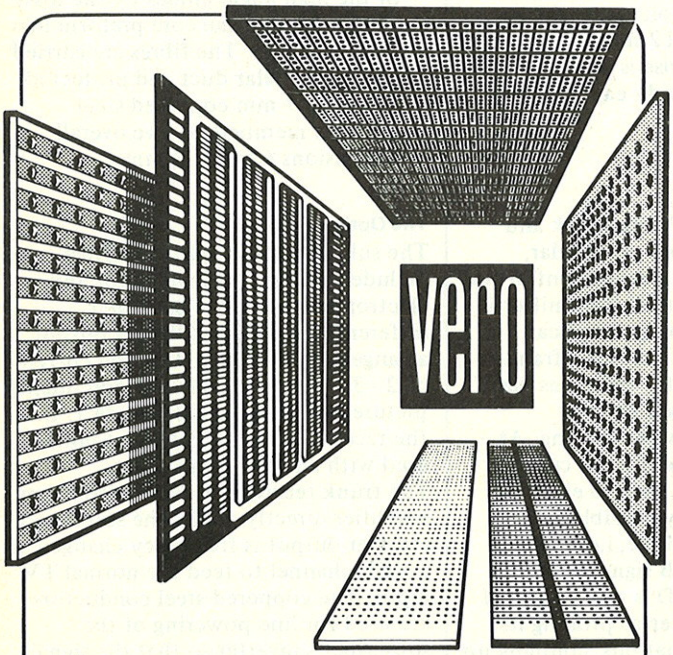

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220	25V	.095
220	63V	.15
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470	25V	.125
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1000	25V	.17
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2200	40V	.46
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.15	35V	.10
.22	35V	.10
.33	35V	.10
.47	35V	.10
.68	35V	.10
1	35V	.10
1.5	35V	.10
2.2	16V	.10
2.2	35V	.11
3.3	16V	.10
10	6.3V	.08
4.7	10V	.10
4.7	35V	.125
6.8	35V	.125
10*	16V	.10
10	25V	.16
10	35V	.16
15	16V	.14
15*	25V	.12
22*	10V	.11
22	16V	.18
22	35V	.20
33	10V	.18
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SELEKTOR

TV into the home by fibre

A Rediffusion Dial-a-Program system recently installed in Arnhem, Holland, is the first cable TV system anywhere in the world to include the use of glass fibre to carry a television signal directly into a home. This is a new development on an installation which has been in operation since the beginning of the year using copper cable to 400 homes.
Dial-a-Program in Arnhem, developed by Rediffusion and now being operated by Delta Kabel B.V., is the prototype of the ultimate in communications systems. It offers almost unlimited channel capacity. Each home has two direct connections to an exchange which is fed by a primary cable network. This can be increased in capacity as the need arises. Access to normal TV services is by means of a touch button pad without the need for stations selection on the TV set. Included are stereo radio programmes. Access to additional services, community TV, etc., will be possible and some, if required, can be on a subscription basis. The twelve programmes which can be made available to subcribers in Arnhem currently include five TV programmes from Holland and Germany while the remaining channels can be used for other TV programmes and information services, including for example, a Reuter's news channel.

Fibre optics field trial

The use of optical transmission in part of the installation in Arnhem is a further step in a current programme to obtain familiarity with the application of fibre optics in local T.V. distribution systems, particularly the connection into the home. It breaks new ground in being the first system anywhere in the world to use optical fibres for this purpose.
The sigma transmitted is on an HF carrier at 8.9 MHz with full lower sideband, taken from the existing Rediffusion Dial-A-Program system which is linked to about 400 homes and is owned and operated by Delta Kabel BV, Rediffusion licencees, in Arnhem, Holland.
The emphasis in this trial is not only to prove that optical fibres can be used for the final connection into the home, but also to show that this can be achieved with components and fibre optic cables only a fraction of the costs of those in most fibre optics systems currently under evaluation for other purposes.
In this trial three fibre optic cables are used, the first in a section of trunk route connecting the aerial site to a DAP exchange, the other two then running from this DAP exchange, one to a receiver in a private house and the other for display purposes back up the trunk route to the aerial site where there is a display room. This means that on selected channels the entire route from the aerial site to the subscriber is run in optical fibre cables. Each section is approximately 250 m long. All transmitting and receiving equipment used in the trial has been produced and installed by Rediffusion Engineering Ltd.
It will be demonstrated at Arnhem that the fibre optic links produce no observable degradation of the signals received by subscribers to the service, the specifications of each optical link being in broad terms similar to those of the copper links to which they are equivalent. The trial represents an important step in the process of applying optical methods to the distribution of television.

The Routes

During the cable laying operation for the main DAP installation, 1" polythene ducts were laid in the trenches so that subsequently, when the fibre optic cable was available it was easily drawn in by Delta Kabel technicians. The subscriber's cable is looped through the subscribers' connection posts which serve groups of 6 or 12 subscribers along the route but otherwise is buried about one metre deep in sandy earth below pavements.

The Transmitters

The transmitters for both trunk and subscriber connections are similar, differing only in the arrangement of the connections. The optical transmitter is an input voltage to output optical power converter and uses an infra red light emitting diode to which has been attached a short lensed fibre to maximise output power coupling. At the receiving end, the photon current arriving is converted back to electron flow and it is thereby possible to recover the original drive, i.e. the original 8.9 MHz VSB signal.
The transmitting LED is run at 40% of maximum rated power to prolong its life in exposed installations, coupling up to 100 μW into the subscriber fibres, which have a high numerical aperture, and 10 μW into the trunk fibre which has smaller NA and core diameter. A short section of fibre with a lensed end is secured in close proximity to the emitting surface and a butt joint to the main fibre is made to this on a grooved copper block using magnetic clamps.
The wavelength of the emitted light is 900 nm, in the near infra-red. Because the FM tv sound signal is also carried, special circuits have been incorporated to compensate the third order distortion of the LED.

The Cables

Both cables are of completely British Manufacture.

1. The trunk cable by TCL contains four separate graded index fibres of core diameter 50 microns, overall diameter 120 microns and 0.13 NA. The fibres have exceptionally low transmission loss – 3 dB/km and high bandwidth – 600 MHz. km. They are, therefore, suitable for use over very much longer routes than in the present trial. The fibres are protected from micro-scratches by a tough varnish and carried in a 2.5 mm duct in a 5 mm diameter polyethylene sheath. Two 22 SWG hard drawn copper strength members are also included.
2. The subscriber cable manufactured by BICC contains two fibres of step index construction with a pure silica core of 120 micron diameter, clad in a clear silicone, polymerized in situ, to give a theoretical NA of 0.34 and a loss over the 250 meters of about 12 dBs. This is largely due to erosion of the high angle modes by the lossy cladding, since the core preform loss is much lower. The fibres are carried in a rectangular duct and protected by two 0.7 mm coppered steel strength members to give overall dimensions 6 mm x 3 mm.

The Optical Receivers

The subscriber and trunk receivers include the same basic detector and electronic circuits but packaged differently and with different output arrangements. Using a detected current of 2 - 3 μA they produce a good quality picture approaching EBU grade 1. In the receiver a silicon PIN photodiode is used with an FET input stage.
The trunk receiver feeds a distribution amplifier directly whilst the subscriber receiver output is frequency changed to a VHF channel to feed the normal TV input. The coppered steel conductors are used for line powering of the subscriber's inverter so that the signal can feed a normal TV set, and in the opposite direction to carry the FSK button dialler signals to the exchange to initiate programme selection.
The fibre terminations for the receiving diodes are made by resting the fibre with a carefully prepared end in a pre-aligned groove pointing to the active area and touching the protective window.

SELEKTOR

The Future

Since in this trial all signal paths from the aerial to the subscriber's home use optical fibres the aim of an 'all-glass' trial has been achieved, and using on the subscriber connection active electro-optic devices and cables of medium technology and price. It is hoped that the growing demand for optical fibre systems will make it possible to obtain these medium technology components or their equivalent at a fraction of their present price. To this end the transmitter assemblies on the transmitter panel in the DAP kiosk are in interchangeable modular form. (364 S)

3 GHz bandwidth waveguide

Two research scientists report the widest optical power bandwidth ever attained in an optical waveguide has been measured in a Corning filament. Frequency response measurements made on six high-bandwidth optical waveguides included one with an extrapolated bandwidth in excess of three gigahertz per kilometer (GHz/km). This measured bandwidth is more than twice that ever recorded in optical waveguides. Wider bandwidth means increased information-carrying capacity.

The bandwidth measurements were reported in 'Measurements on High Bandwidth Optical Waveguides', a paper co-authored by Keck and R. Bouillie, chief, optical cable and systems studies, Centre National d'Etudes des Telecommunications (CNET) in France.

M. Bouillie and Dr. Keck collaborated on the report of measurements made by them in the summer of 1977 at their respective laboratories.

To accomplish the precise laboratory measurements described in the report, Corning prepared six graded index optical waveguides for the tests on production equipment. Testing took place at CNET in Lannion, France. CNET is the research branch of the French national telephone company (PTT).

All the waveguides tested were made by the outside vapor phase oxidation (OVPO), doped deposited silica (DDS) process. Each had a germanium-borosilicate radially graded core with a borosilicate cladding. Standard testing procedures were observed. Bandwidth measurement was done by injecting short light pulses into the waveguides and directly recording the output frequency response with a spectrum analyser to the equipment limit of 1800 megahertz (MHz). The measured response was mathematically fitted to an empirical relation. The light source used for the measurements was a gallium arsenide laser diode emitting at 850 nm. To avoid material dispersion limitation, the light was launched into a preceding 10-meter length of waveguide to more uniformly excite the waveguides under test. Source spectral bandwidth was about 0.4 nm. The output from the 10-meter section was butt-coupled to each waveguide by use of a micropositioner.

Of the six waveguides tested, the highest three dB optical power bandwidths measured were 3100 MHz and 1800 MHz. The former value had to be mathematically extrapolated because it exceeded the direct measurement capability of the test euipment. Of the remaining four waveguides, all had bandwidths greater than 1000 MHz, the lowest being 1240 MHz/km.

Corning said that the zero frequency attenuation rate of the waveguides tested was very low, and as a result, mode-coupling and/or differential attenuation effects were not significant factors in generating the wide bandwidth measurements.

The waveguide having the highest measurement — 3100 MHz — had a numerical aperture of 0.18 and an equivalent step profile bandwidth of approximately 17 MHz/km. Thus, this waveguide had a profile pulse reduction factor of about 175. This compares with previous high factors of less than 100.

Corning said the present high-bandwidth waveguide is proof that optical fibers with profile-limited bandwidths in excess of 3000 MHz/km (3 GHz/km) can be made by the OVPO process.

The six waveguides measured in the test are now part of a six-kilometer 140 Mbit/sec optical link installed underground at CNET. When all six waveguides were connected in series, link bandwidth was measured at 300 MHz. This work was reported at the Third European Conference on Optical Fiber Communication in Munich in 1977.

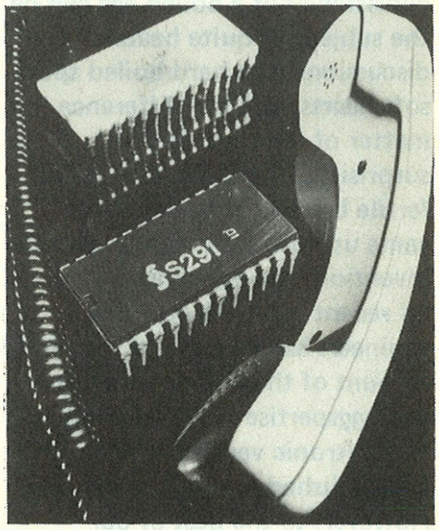
The report on wide optical power bandwidth further notes that a companion waveguide made from the same OVPO process preform also exhibits extremely high bandwidth and appears to follow the wavelength dependence predicted by theory and measured material properties.

Corning Glass Works,
Corning, N.Y. 14830,
USA (363 S)

Codec for the telephone

Siemens has developed a PCM 2-channel codec consisting of two LSI circuits — SM 61A (in MOS technology) and S 291 (bipolar). With these circuits it is possible to convert analog speech signals into digital form (coding) for transmission by means of pulse code modulation (PCM) and to convert the digital signals back again into analog signals (decoding). The coding/decoding can be performed at any point in a telephone connection, e.g. along the transmission path, at the switching center or in the telephone terminal.

With the 8 kHz sampling rate recommended by CCITT a maximum of two 4 kHz voice channels can be assigned to the codec. Alternatively, coding and decoding of one 8 kHz voice channel is possible, the sampling rate then being 16 kHz. Siemens is one of the first firms to produce a fully integrated version of such a code system in compliance with CCITT recommendations.



The features of codec system SM 61A/S 291 can be summarized as follows:

* A-companding as per CCITT G.711,
* 2.048 MHz serial PCM interface for a PCM 30/32 system,
* all digital interfaces are TTL compatible,
* PCM switching by means of an external channel pulse control unit,
* reading-in and reading-out of PCM words are carried out independently of each other and in no fixed sequence,

Codec system SM 61A/S 291 is suitable for the following applications:

Transmission systems:

* Multiplex terminal unit

Switching systems:

* Digital subscriber circuit
* Single-stage concentrator (32 through-connected channels)
* Single-stage switching network for private systems and PABXs (32 through-connected channels)

Siemens AG,
Postfach 103, D-8000 Munchen 1,
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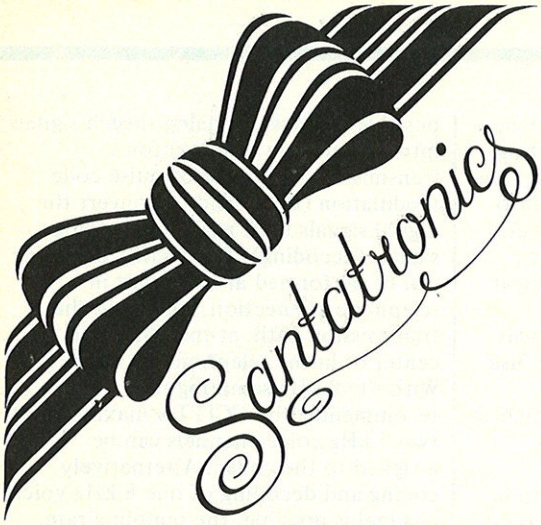


cackling egg-timer

Boiling eggs is one of the more delicate of culinary occupations, especially since the ideal consistency of a boiled egg can be the subject of quite heated discussions: the hard-boiled spurn soft hearts, and the difference is a matter of minutes. It is not surprising, therefore, that some fertile brain in the distant past came up with that highly practical invention: the egg-timer.
Of recent years, electronics engineers have devoted a surprising amount of their time, ingenuity and eggspertise into the quest for an electronic version, and circuits are published at regular intervals. However, to the best of our knowledge, the circuit presented here is the first to cackle loudly when the timing period has elapsed!

Electronics is invading the most unlikely fields. After several experiments, with sometimes highly comical results, a member of the Elektor design team has even succeeded in imitating the sound of a self-satisfied hen – using a single CMOS IC. A simple timer, consisting of two further ICs, completes the novel egg-timer.

The block diagram is shown in figure 1. The timer section is fairly conventional. A decade counter receives pulses from a clock generator. Since the period time of the clock generator is 1 minute, the decade counter effectively counts minutes. The counter is started by pressing the 'reset' button. When the time selected by the multi-position switch has elapsed, two things happen: the clock generator is blocked, stopping the count, and the electronic switch (S) is closed. This switch applies power to the second part of the circuit, enclosed in dotted lines: the 'cackle circuit' that imitates the smugly complacement hen. This circuit consists of three square-wave generators, two of which are voltage-controlled (the VCOs).

The three generators are labelled according to the frequency they produce: 'L' for low, 'M' for mid-range and 'H' for high frequency – relatively, of course. The audio signal is derived from the third VCO ('H'). The other VCO, 'M', provides the basic modulation required for the 'bock-bock-bock' effect. The first generator adds two further effects: the repetition rate of the cackling and the duration of each cycle. These two effects, combined, also determine the number of clucks-per-cycle.

If one considers the characteristic

1

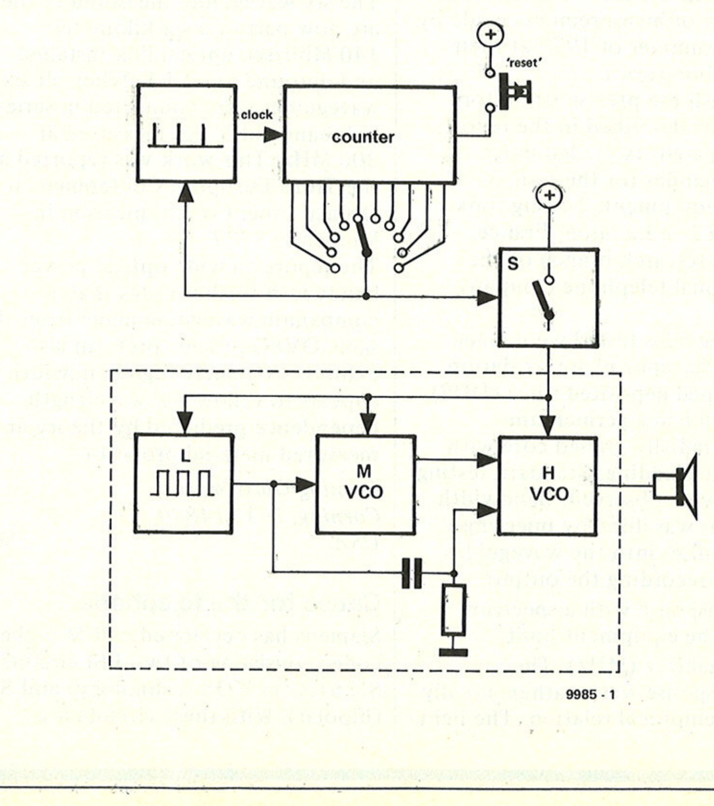
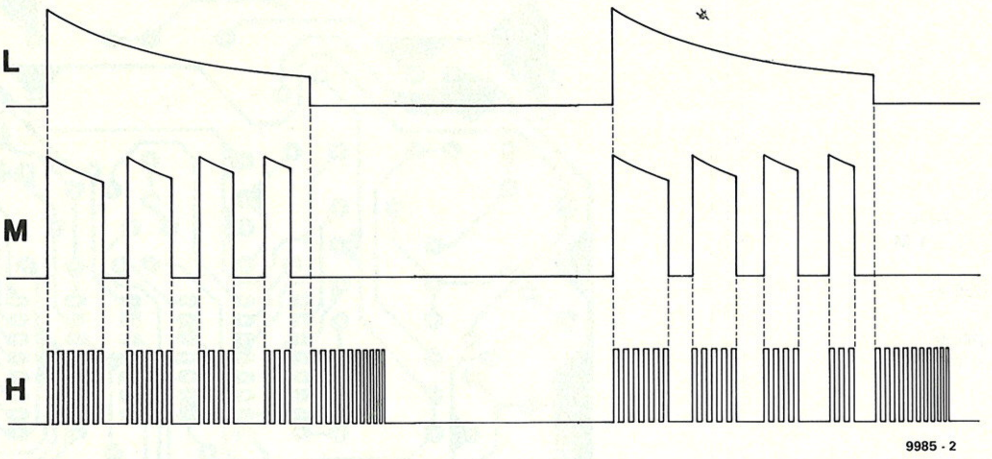


Figure 1. Block diagram of the cackling egg-timer. The section enclosed in dotted lines is the 'cackle generator'.

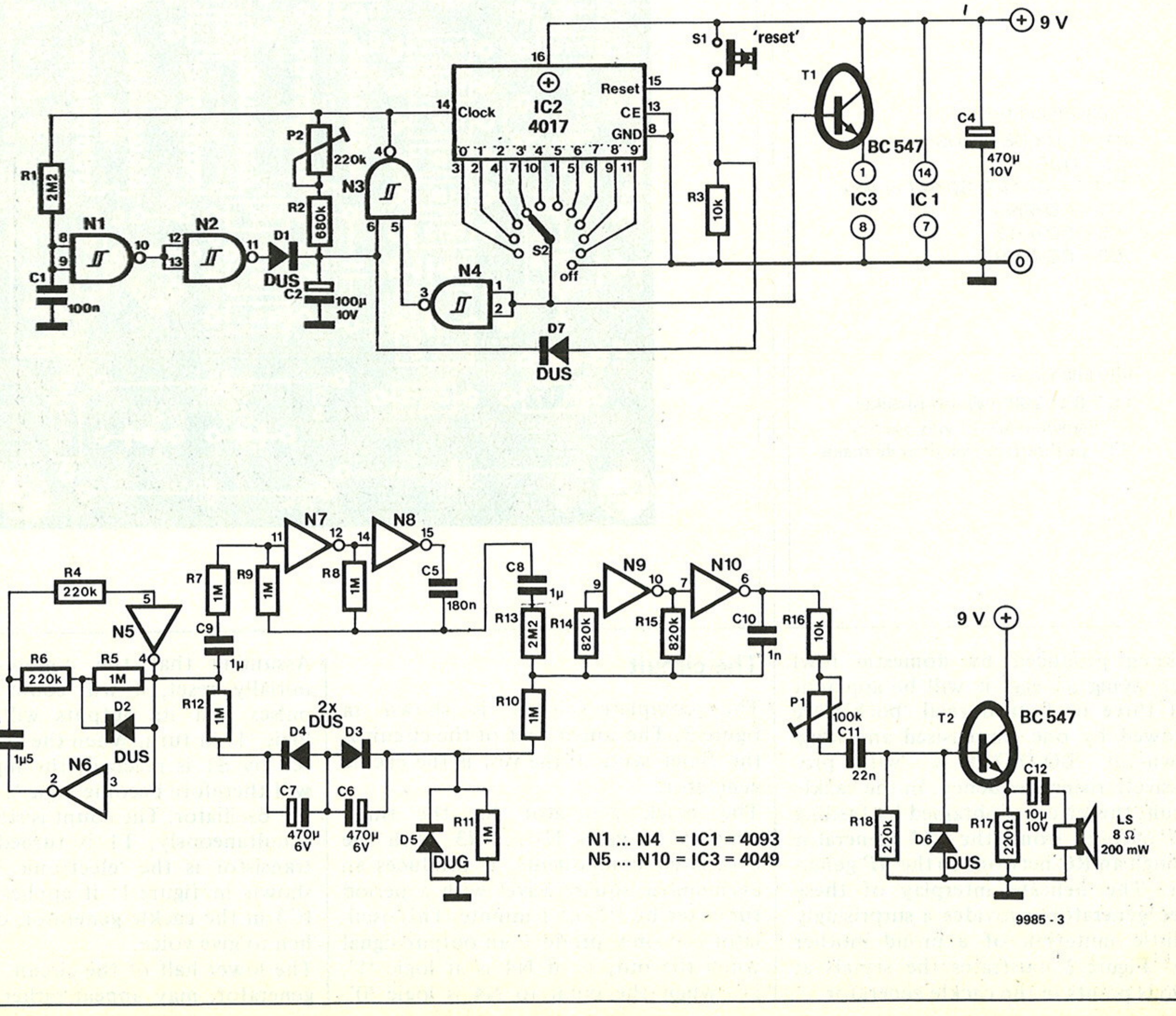
Figure 2. Output waveforms from the three oscillators in the cackle generator.

Figure 3. The complete circuit. The upper portion is the timer; the lower section is the cackle generator.

2


L
M
H
9985 - 2

3


R1
2M2
C1
100n
N1
8
9
10
N2
12
13
11
D1
DUS
P2
220k
R2
680k
C2
100μ
10V
N3
4
6
5
N4
3
1
2
D7
DUS
IC2
4017
Clock
14
16
Reset
15
CE
13
GND
8
'0' '1' '2' '3' '4' '5' '6' '7' '8' '9'
3 2 4 7 10 1 5 6 9 11
S2
off
S1
'reset'
R3
10k
T1
BC 547
IC3
1
8
IC 1
14
7
C4
470μ
10V
9 V
0
R4
220k
N5
5
4
R6
220k
R5
1M
D2
DUS
C3
1μ5
N6
2
3
R7
1M
R9
1M
C9
1μ
R12
1M
N7
11
12
N8
14
15
R8
1M
C5
180n
2x DUS
D4
D3
C7
470μ
6V
C6
470μ
6V
D5
DUG
R11
1M
C8
1μ
R13
2M2
R10
1M
N9
9
10
R14
820k
N10
7
6
R15
820k
C10
1n
R16
10k
P1
100k
C11
22n
9 V
T2
BC 547
R18
220k
D6
DUS
R17
220Ω
C12
10μ
10V
LS
8 Ω
200 mW
N1 ... N4 = IC1 = 4093
N5 ... N10 = IC3 = 4049
9985 - 3

Parts list

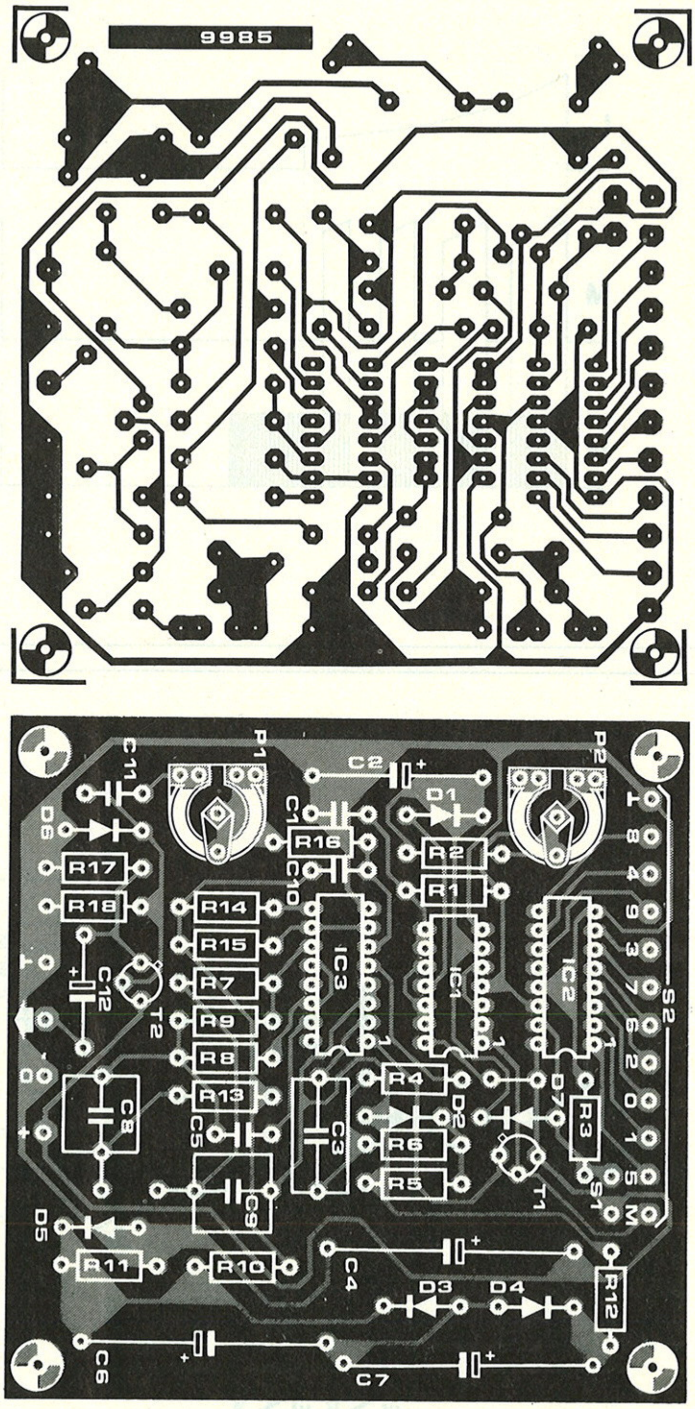
Resistors:
R1 = 100 k
R2 = 680 k
R3,R16 = 10 k
R4,R6,R18 = 220 k
R5,R7 . . . R12 = 1 M
R13 = 2M2
R14,R15 = 820 k
R17 = 220 Ω
P1 = 100 k, preset
P2 = 220 k, preset

Capacitors:
C1 = 10 n
C2 = 100 μ/10 V
C3 = 1μ5
C4 = 470 μ/10 V
C5 = 180 n
C6,C7 = 470 μ/6 V
C8,C9 = 1 μ
C10 = 1 n
C11 = 22 n
C12 = 10 μ/10 V

Semiconductors:
D1 . . . D4,D6 = DUS
D5 = DUG
T1,T2 = BC 107, BC 547 or equ.
IC1 = CD 4093
IC2 = CD 4017
IC3 = CD 4049

Miscellaneous:
LS = 8 Ω/200 mW loudspeaker
S1 = single-deck 11-way switch
S2 = pushbutton, single-pole make

4



cackling produced by domestic fowl after laying an egg, it will be apparent that three or four normal 'bock's are followed by one emphasised and long-drawn-out 'BO-O-O-O-CK' with progressively rising frequency. In the cackle circuit, this effect is obtained by feeding the output from the 'L' generator through an RC-network to the 'H' generator. The delicate interplay of these three generators provides a surprisingly realistic imitation of a proud mother hen. Figure 2 illustrates the signals at various points in the cackle generator.

The circuit

The complete circuit is shown in figure 3. The upper half of the circuit is the timer section; the rest is the cackle generator.

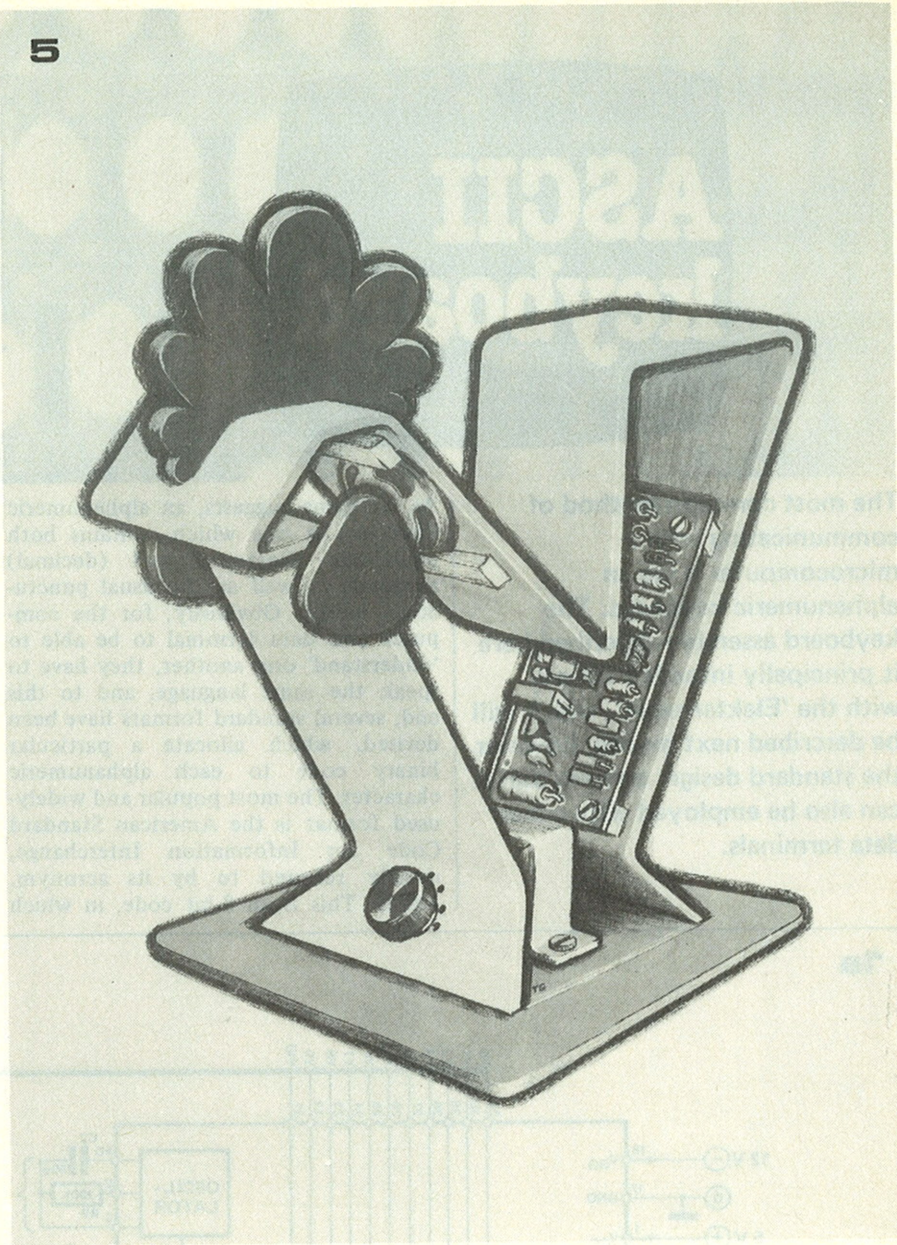
The clock generator for the timer consists of gates N1 . . . N3, with the associated components. It produces an asymmetric square-wave, with a period time (set by P2) of 1 minute. This oscillator can only produce an output signal when the output of N4 is at logic '1', i.e. when the input to N4 is logic '0'. Assuming that the counter, IC2, is initially reset, it will count the clock pulses and its outputs will swing to logic '1' in turn. When the output selected by S1 is reached, the input to N4 will therefore become logic '1', stopping the oscillator. The count is stopped and, simultaneously, T1 is turned on. This transistor is the 'electronic switch', S, shown in figure 1: it applies power to IC3 in the cackle generator, causing the hen to give voice.

The lower half of the circuit, the cackle generator, may appear rather confusing

Figure 4. Printed circuit board and component layout for the cackling egg-timer (EPS 9985).

Figure 5. When it comes to 'Santatronics', the gift-wrapping is almost as important as the contents. The demonstration model shown here is perhaps somewhat large for normal domestic use, but it may help to stimulate the imagination.

5



at first sight. Reference to the block diagram may help to clarify matters. The free-running generator 'L' consists of N5 and N6; the 'M' and 'H' VCOs are similar circuits using N7/N8 and N9/N10, respectively.

A diode, D2, is included in the 'L' generator to obtain an asymmetrical output signal. This signal is fed, via C9 and R7, to the 'M' VCO. The output from the 'M' VCO now contains most of the information required for the 'bock-bock-bock-bo-o-o-ock' effect. As illustrated in figure 2, the number and length of the 'bock's, the breathing space and the (rising) frequency shift are all determined, with one exception: the modulation for the final, long-drawn-out 'b-o-o-o-ck'. This signal is derived from the output of the 'L' generator via an RC network consisting of R10, R11, R12, C6, C7 and three diodes. Capacitors C6 and C7 and diodes D3 and D4 together are basically equivalent to a bipolar electrolytic. D5 limits the negative swing of the voltage across R11. The outputs from the 'M' generator and from the RC network are summed and applied to the 'H' generator, which produces the actual audio signal.

A single-transistor buffer stage, T2, drives the loudspeaker. The desired volume can be set with P1.

Construction

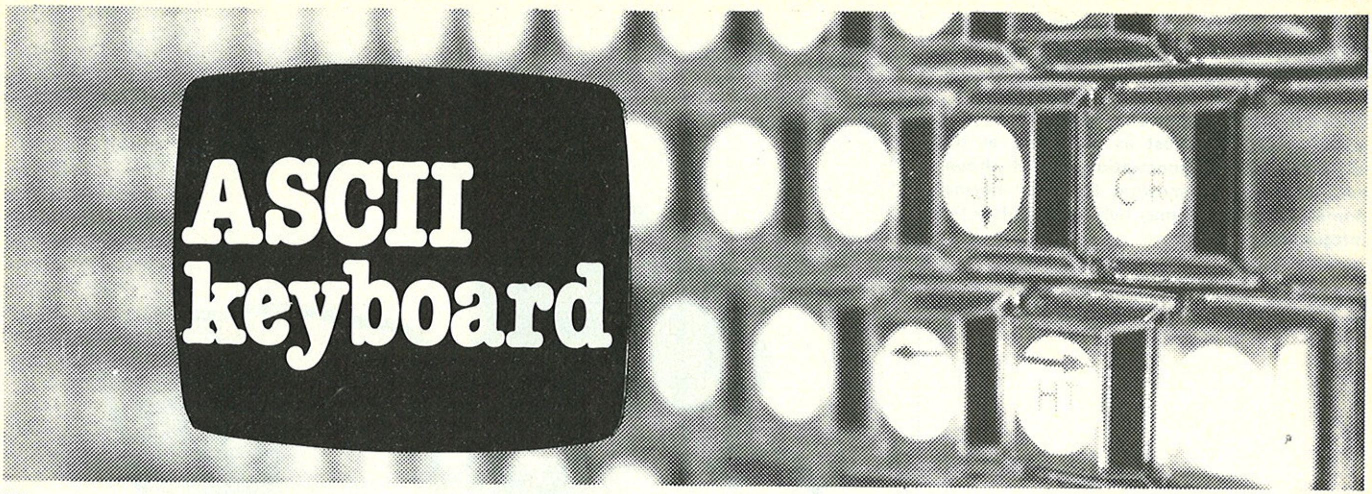
The electronics involved in the egg-timer can be mounted on the printed circuit board shown in figure 4. The supply voltage (9 V) and the low current consumption make the circuit suitable for battery operation. If a mains supply is used, due care must be taken to reliably insulate the complete unit: it will be used in decidedly damp surroundings, quite possibly beside the kitchen sink!

There are only two adjustments. As mentioned earlier, P1 sets the desired volume. P2 is used to calibrate the timer. The easiest way to do this is to set S1 to position '1' and adjust P2 until the timing interval (i.e. the time between pressing the reset button and the first squawk) is exactly one minute. The switch positions will then correspond to timing intervals in minutes.

There is, of course, no reason why P2 should not be set to give a different timing interval. For instance, if the initial period is set at 1½ minutes, the switch positions will correspond to multiples of this time. Position 2 will be 3 minutes, position 3 will correspond to 4½ minutes, and so on. Position 9 would then be 9 x 1½ = 13½ minutes — ideal for 'bullet'-lovers.

No matter what the setting of P2, position 0 will always correspond to 0 minutes: the hen will give voice as soon as the reset button is operated. This option is included mainly for demonstration purposes.

As with most 'Santatronics' circuits, the 'gift' value is greatly enhanced by the wrapping. Since this is an ideal challenge to individual creativity, no constructional details for a case will be given here. Just a suggestion: a novel idea would be to shape it like an egg or, of course, a hen. Perhaps some further inspiration can be gained from figure 5: our demonstration model, which has been one of the center-pieces at otherwise serious exhibitions! ◾



ASCII keyboard

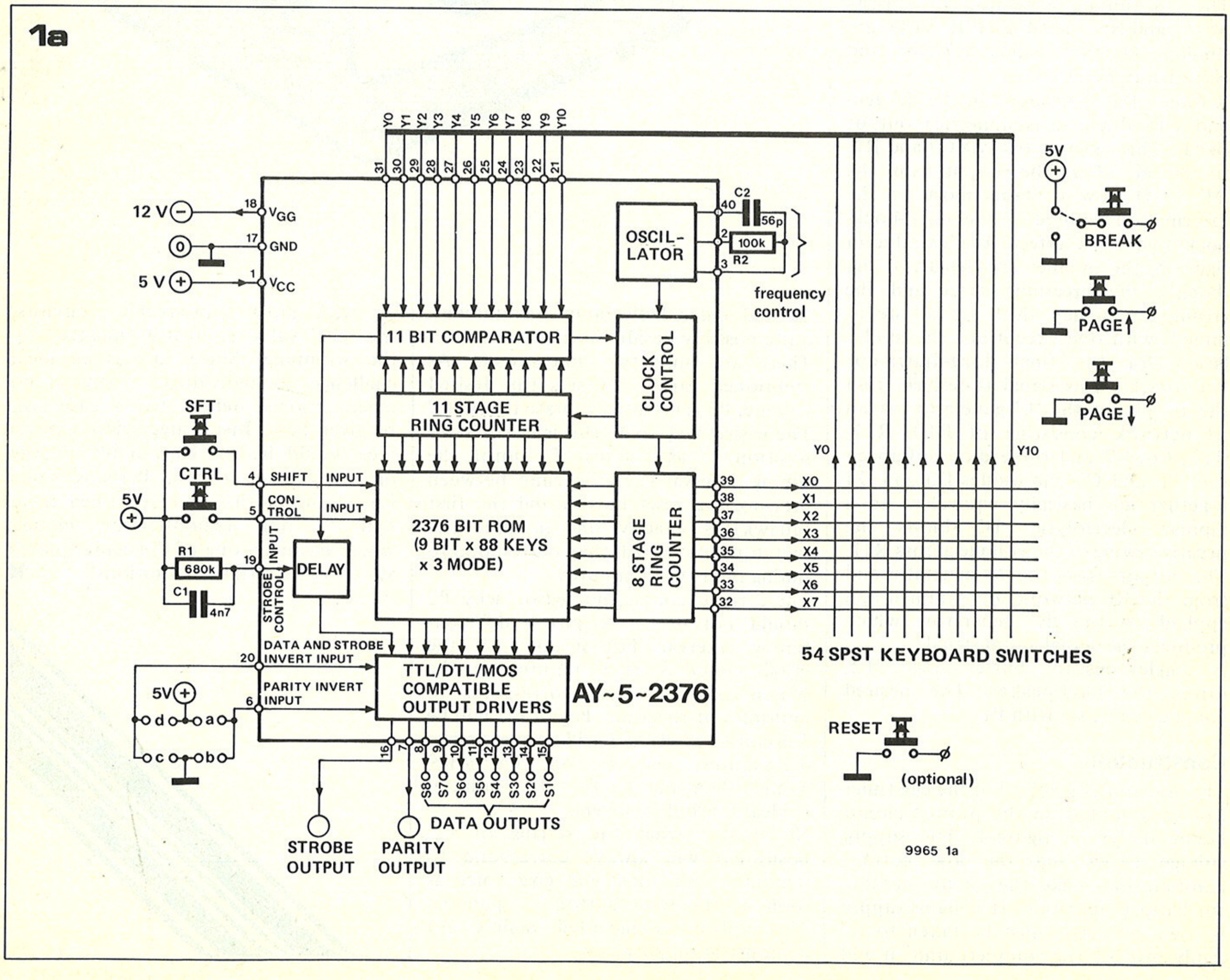
The most common method of communicating with a microcomputer is via an alphanumeric keyboard. The keyboard assembly described here is principally intended for use with the 'Elekterminal', which will be described next month, however the standard design ensures that it can also be employed with other data terminals.

As its name suggests, an alphanumeric keyboard is one which contains both alphabetic characters and (decimal) numerals as well as the usual punctuation marks. Obviously, for the computer and data terminal to be able to 'understand' one another, they have to speak the same language, and to this end, several standard formats have been devised, which allocate a particular binary code to each alphanumeric character. The most popular and widely-used format is the American Standard Code for Information Interchange, usually referred to by its acronym, ASCII. This is an 8-bit code, in which the most significant bit (MSB) is used as a parity bit for error detection. Since 7 binary digits can be arranged in 128 different combinations, it is clear that a considerable number of the 7-bit codes are left over once all the decimal digits, alphabetic characters and punctuation symbols have been catered for. In the ASCII format the remaining codes are assigned control functions. A complete listing of the ASCII character set, with an explanation of the control characters, is shown in table 1.

Keyboard circuit

Although, in principle, it would be

1a



1b

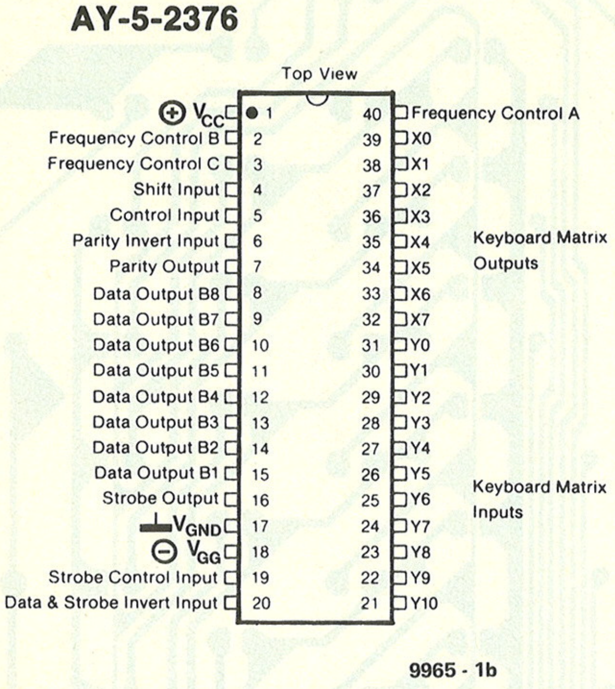
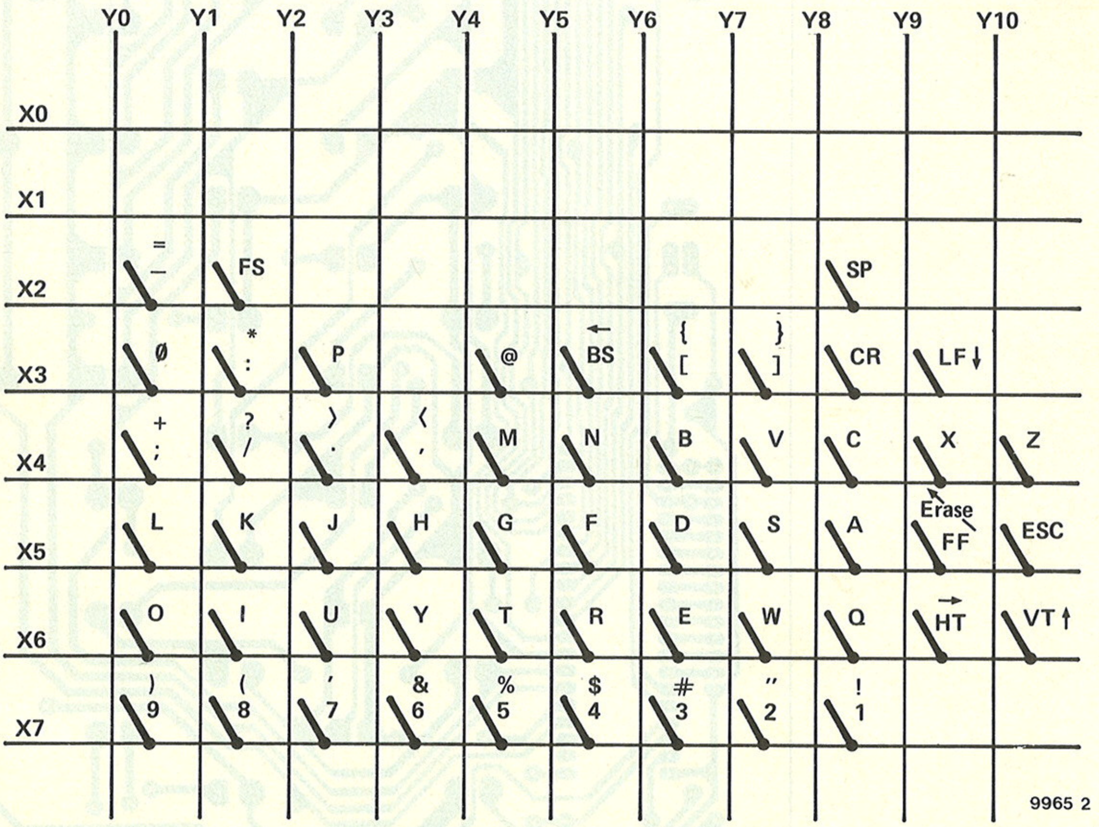


Figure 1. Pin configuration and block diagram of the AY-5-2376 amount to a circuit diagram of the keyboard.

Figure 2. This figure illustrates which elements of the matrix are occupied by keys.

2



parts list to figures 1, 3 and 4

Resistors:
R1 = 100 k
R2 = 680 k

Capacitors:
C1 = 4n7
C2 = 56 p

Semiconductors:
IC1 = AY-5-2376 (General Instruments) £13.81 MAPLIN

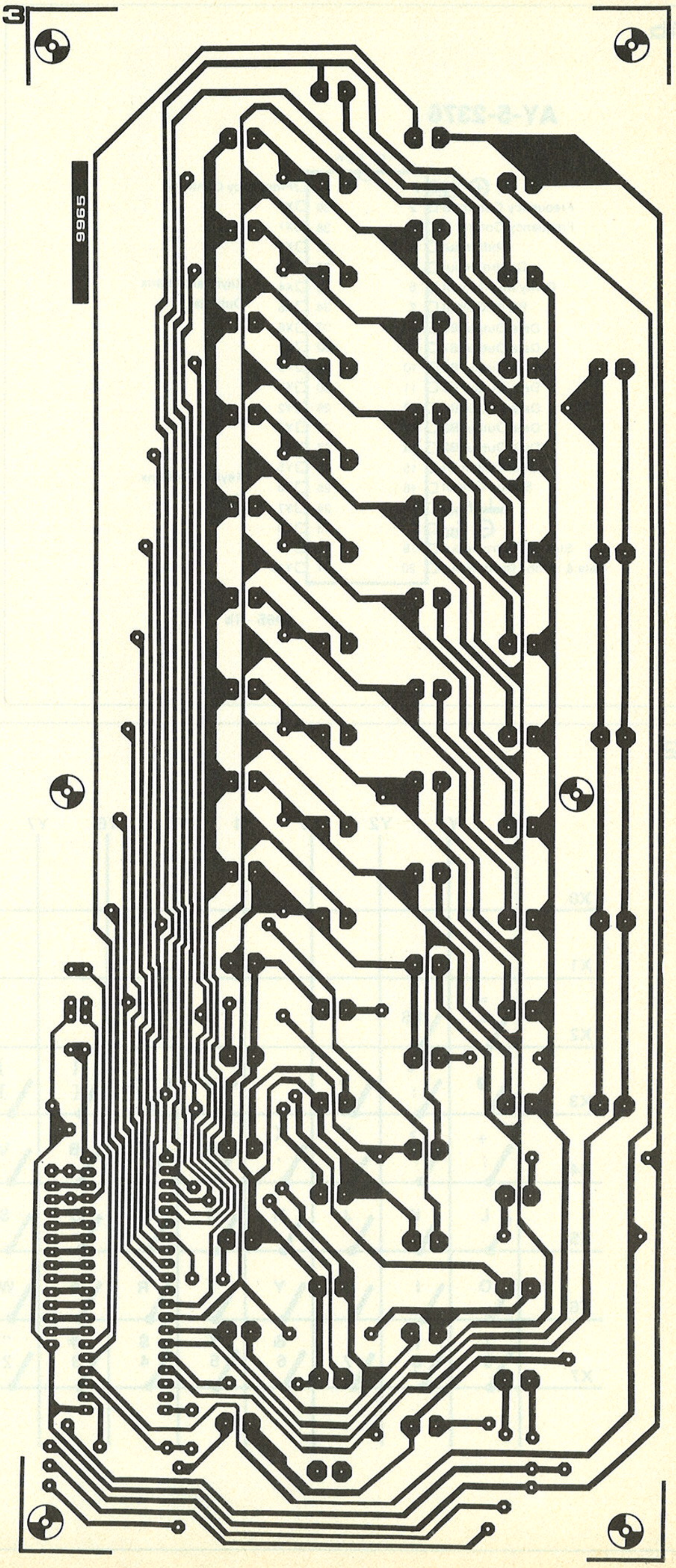
Miscellaneous:
62 keyboard switches: TKC type MM9 — 2

We have been informed that the TKC switches are to be supplied in the UK by the following companies (see advertisement section for further details):
Astec Europe Ltd., Windsor
De Boer Electronics, Eindhoven
Marshall's Ltd., London

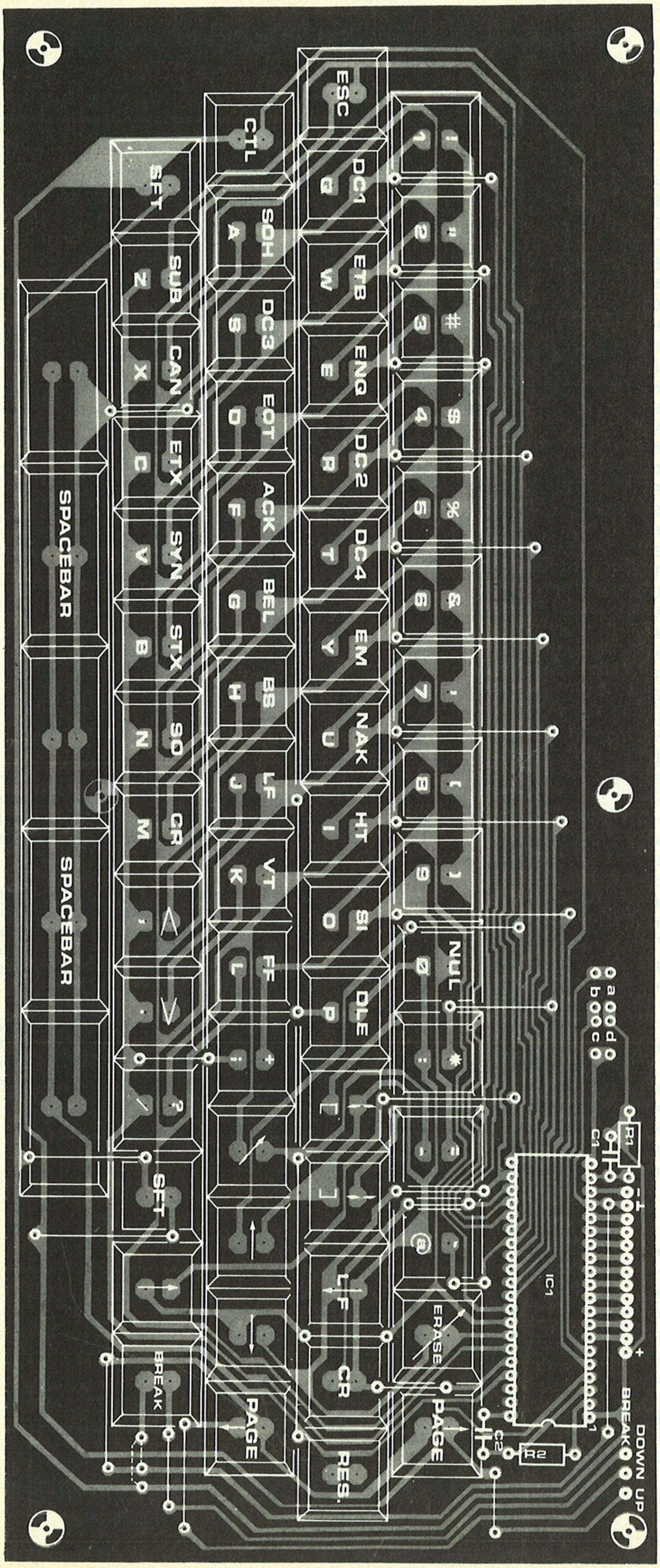
Figure 3. Track pattern of the keyboard p.c.b. (EPS 9965).

Figure 4. Component overlay of the keyboard p.c.b.
Note that the copper layout and component overlay are reproduced here at 90% of actual size.

3



4



possible to design a keyboard which had a separate key for each of the 128 characters, it would obviously be not only extremely expensive, but rather unwieldy. Thus, as is the case with typewriters, each key is normally assigned a double (or triple) function, with a shift key to determine which of the codes which correspond to a particular key is in fact generated.

The key closures are converted into ASCII code by means of an encoder IC; this is basically little more than a ROM in which the complete ASCII code is stored, and which is addressed by the keyboard. There are several IC encoders currently available, the one used here is the AY-5-2376 from General Instruments. Pin-out details and internal block diagram of the IC – which constitutes virtually the entire circuit diagram of the keyboard – are shown in figure 1.

In order to keep the wiring of the keyboard as simple as possible, the keys are arranged in a matrix as shown in figure 2. For reasons which will become clear, not every point in the matrix requires a key. In addition to those keys in the matrix, several additional keys are shown in figure 1, namely a break key, two page keys, a reset key, a shift key and a control key. The break- and page keys are intended for the Elekterminal (to be described next month), whilst the reset key is optional. The shift- and control keys are used to select the different functions of each key in the keyboard matrix. This is illustrated in table 2, which lists the characters obtained when the 'N' (normal), 'S' (shift) and 'C' (control) keys are depressed. As can be seen, a large number of characters occur more than once in the table, which is the reason why not all the points in the matrix need be occupied by keys.

A number of ASCII characters are assigned non-standard functions in the Elekterminal. These are listed in table 3, along with an explanation of their new function. If the keyboard is used with other data terminals, then the characters can, of course, retain their original significance.

All mechanical switches are prone to a certain amount of contact bounce. In order to eliminate the effects of this the IC contains a delay network which can be controlled externally. The length of delay is determined by the time constant R1/C1. Via wire links a, b, c and d, pins 6 and 20 of the IC can be connected either to a '0' or '1' voltage level. In the latter case, the data outputs, strobe-output and parity output are inverted. In normal use these pins are grounded, i.e. only links c and b are made.

Construction

In order to facilitate construction of the keyboard a printed circuit board was designed, which is intended to accomo-

Table 1.

Character	Binary Bit 7 to Bit 0	Hexadecimal	Character	Binary Bit 7 to Bit 0	Hexadecimal
NUL	00000000	00	@	01000000	40
SOH	00000001	01	A	01000001	41
STX	00000010	02	B	01000010	42
ETX	00000011	03	C	01000011	43
EOT	00000100	04	D	01000100	44
ENQ	00000101	05	E	01000101	45
ACK	00000110	06	F	01000110	46
BEL	00000111	07	G	01000111	47
BS	00001000	08	H	01001000	48
HT	00001001	09	I	01001001	49
LF	00001010	0A	J	01001010	4A
VT	00001011	0B	K	01001011	4B
FF	00001100	0C	L	01001100	4C
CR	00001101	0D	M	01001101	4D
SO	00001110	0E	N	01001110	4E
SI	00001111	0F	O	01001111	4F
DLE	00010000	10	P	01010000	50
DC1	00010001	11	Q	01010001	51
DC2	00010010	12	R	01010010	52
DC3	00010011	13	S	01010011	53
DC4	00010100	14	T	01010100	54
NAK	00010101	15	U	01010101	55
SYN	00010110	16	V	01010110	56
ETB	00010111	17	W	01010111	57
CAN	00011000	18	X	01011000	58
EM	00011001	19	Y	01011001	59
SUB	00011010	1A	Z	01011010	5A
ESC	00011011	1B	[	01011011	5B
FS	00011100	1C	\	01011100	5C
GS	00011101	1D	]	01011101	5D
RS	00011110	1E	↑	01011110	5E
US	00011111	1F	←	01011111	5F
SP	00100000	20	`	01100000	60
!	00100001	21	a	01100001	61
"	00100010	22	b	01100010	62
'	00100011	23	c	01100011	63
$	00100100	24	d	01100100	64
%	00100101	25	e	01100101	65
&	00100110	26	f	01100110	66
'	00100111	27	g	01100111	67
(	00101000	28	h	01101000	68
)	00101001	29	i	01101001	69
*	00101010	2A	j	01101010	6A
+	00101011	2B	k	01101011	6B
,	00101100	2C	l	01101100	6C
—	00101101	2D	m	01101101	6D
.	00101110	2E	n	01101110	6E
/	00101111	2F	o	01101111	6F
0	00110000	30	p	01110000	70
1	00110001	31	q	01110001	71
2	00110010	32	r	01110010	72
3	00110011	33	s	01110011	73
4	00110100	34	t	01110100	74
5	00110101	35	u	01110101	75
6	00110110	36	v	01110110	76
7	00110111	37	w	01110111	77
8	00111000	38	x	01111000	78
9	00111001	39	y	01111001	79
:	00111010	3A	z	01111010	7A
;	00111011	3B	{	01111011	7B
<	00111100	3C	|	01111100	7C
=	00111101	3D	}	01111101	7D
>	00111110	3E	~	01111110	7E
?	00111111	3F	DEL	01111111	7F

NUL	null, or all zeros
SOH	start of heading
STX	start of text
ETX	end of text
EOT	end of transmission
ENQ	enquiry
ACK	acknowledge
BEL	bell
BS	backspace
HT	horizontal tabulation
LF	line feed
VT	vertical tabulation
FF	form feed
CR	carriage return
SO	shift out
SI	shift in
DLE	data link escape
DC1	device control 1
DC2	device control 2
DC3	device control 3
DC4	device control 4
NAK	negative acknowledge
SYN	synchronous idle
ETB	end of transmission block
CAN	cancel
EM	end of medium
SUB	substitute
ESC	escape
FS	file separator
GS	group separator
RS	record separator
US	unit separator
SP	space
DEL	delete

Table 1. This table lists the complete ASCII character set, along with the corresponding binary and hexadecimal values for each character.

Table 2. This table illustrates the relationship between the keyboard matrix and the corresponding set of characters. It is apparent that, since several characters appear more than once, a key is not required for every element of the matrix.

Table 3. A number of ASCII characters are assigned non-standard functions in the Elekterminal. This table indicates which characters are involved and also their new significance.

Figure 5. Keyboard layout.

date all the necessary hardware (i.e. including the keys). Figures 3 and 4 show the copper track pattern and component overlay respectively. The board layout is designed to take TKC type MM9 keyboard switches. The keyboard layout is illustrated in figure 5. A certain amount of care should be used when mounting the keys. Since they are only held in place by their terminal pins one must be careful to ensure that the keys are correctly positioned, otherwise there is the danger that the key tops may touch one another and a key will remain depressed after being hit. The best solution is to mount the keys row by row, using a jig or template to hold the keys in place.

The connections between the keyboard and receiver section of the terminal are best made using ribbon cable, via which the keyboard can simultaneously be provided with the necessary supply voltages of +5 and −12 V. The current consumption of both supplies is a maximum of 10 mA.

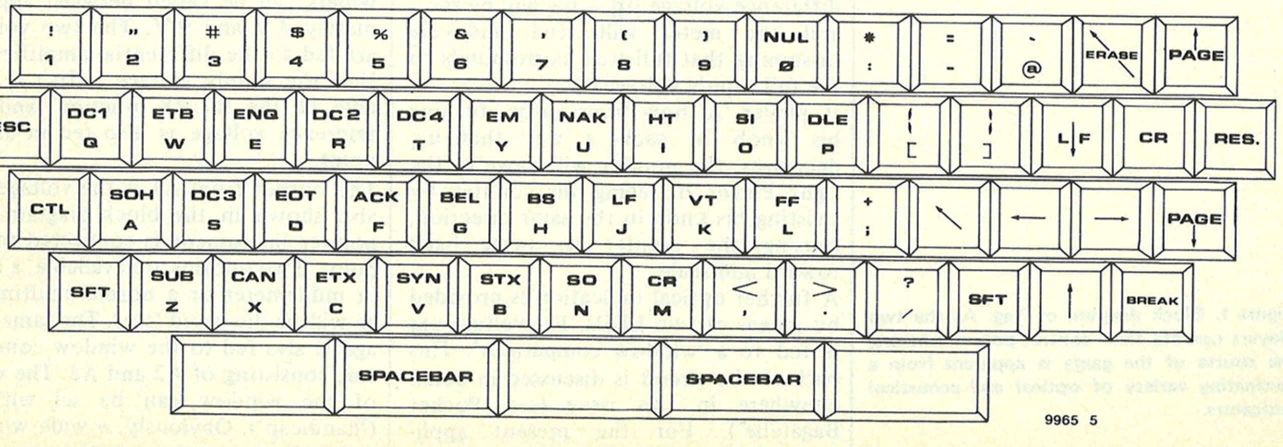
Table 2.

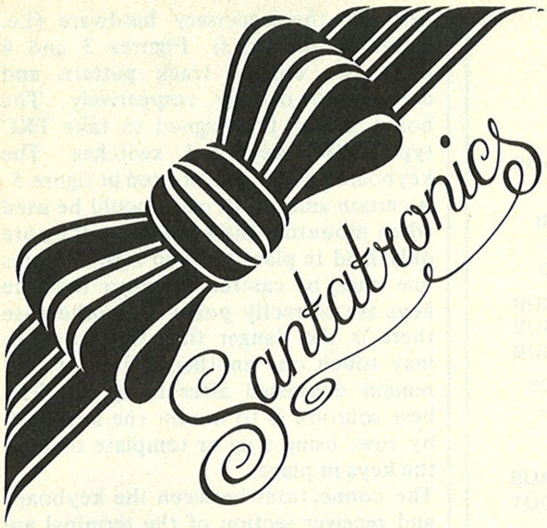
C: control S: shift N: normal		y 0	y 1	y 2	y 3	y 4	y 5	y 6	y 7	y 8	y 9	y 10
x 0	C	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	DC1	DLE	SI
	S	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	DC1	@	←
	N	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	DC1	P	O
x 1	C	DLE	VT	FF	SO	CR	NAK	SYN	ETB	CAN	EM	SUB
	S	DLE	[	\	↑	]	NAK	SYN	ETB	CAN	EM	SUB
	N	DLE	K	L	N	M	NAK	SYN	ETB	CAN	EM	SUB
x 2	C		FS	GS	RS	US				SP		US
	S	=	FS	GS	RS	US	<	>	,	SP	.	←
	N	–	FS	GS	RS	US	<	>	,	SP	.	←
x 3	C			DLE	US		BS	ESC	GS	CR	LF	RUB OUT
	S		*	P	DEL	`	BS	{	}	CR	LF	
	N	0	:	p	←	@	BS	[	]	CR	LF	
x 4	C					CR	SO	STX	SYN	ETX	CAN	SUB
	S	+	?	>	<	M	N	B	V	C	X	Z
	N	;	/	.	,	m	n	b	v	c	x	z
x 5	C	FF	VT	LF	BS	BEL	ACK	EOT	DC3	SOH	FF	ESC
	S	L	K	J	H	G	F	D	S	A	FF	ESC
	N	l	k	j	h	g	f	d	s	a	FF	ESC
x 6	C	SI	HT	NAK	EM	DC4	DC2	ENQ	ETB	DC1	HT	VT
	S	O	I	U	Y	T	R	E	W	Q	HT	VT
	N	o	i	u	y	t	r	e	w	q	HT	VT
x 7	C										RS	FS
	S	)	(	'	&	%	$	=	"	!	ESC	|
	N	9	8	7	6	5	4	3	2	1	↑	\

Table 3.

CTL	+	L	=	FF	(FORM FEED)	=	home cursor + page clear
CTL	+	J	=	LF	(LINE FEED)	=	LF + cursor ↓
CTL	+	I	=	HT	(HORIZONTAL TAB)	=	cursor →
CTL	+	K	=	VT	(VERTICAL TAB)	=	cursor ↑
CTL	+	M	=	CR	(CARRIAGE RETURN)	=	CR = erasure to end of line
CTL	+	H	=	BS	(BACK SPACE)	=	cursor ←
CTL	+	\	=	FS	(FILE SEPARATOR)	=	home cursor
SFT	+	↑	=	ESC	(ESCAPE)	=	scroll up
CTL	+	Z				=	erasure of current line

5





Tag!

a strenuous game can be played without physical effort

One of the simpler games known to man is 'Tag'. Variations of the game were probably played by cave-men. There are very few rules: it is simply a question of one person being 'him' or 'it', and running around trying to 'catch' or 'tag' the other player(s). What the game lacks in sophistication, it makes up for in sheer physical strenuousness. In its basic form it is not really a parlour game, either; the risk of toppling tables, falling flowers and the cat in the curtains is more than most parents are prepared to take. Since the main characteristics of the coming months are snow, sleet and Santa Claus, a safe, indoor version of the game should prove welcome.

Figure 1. Block diagram of Tag. As the two players operate their control potentiometers, the course of the game is apparent from a fascinating variety of optical and acoustical indicators.

Figure 2. The complete circuit.

Instead of running like mad, the two players of the electronic version of tag merely twist the knob of a potentiometer madly to and fro. The rules are as simple as in the original game: player 'A' attempts to manipulate his knob in such a way that the pointer of a multimeter moves out of a small area around mid-scale; player 'B' does his utmost with *his* knob to keep the pointer within the area. In other words, player 'A' tries to 'run away', and player 'B' tries to catch him. If 'B' is successful, in that he succeeds in tracking 'A' for a sufficient length of time, a LED lights to indicate that 'B' has 'caught' his opponent.

To increase the effect, sound effects are included: the player controls also sweep two oscillators up and down. The outputs from these oscillators can be fed to the two channels of a stereo amplifier, producing penetrating wails that sweep up and down through the audio range.

The block diagram (figure 1) illustrates the basic principles involved. The control potentiometers 'A' and 'B' provide voltages u_A and u_B. The difference voltage $u_B - u_A$ is determined, and added to half the supply voltage U_b. The result is a voltage u_M which swings to and fro around $½U_b$, depending on the values of u_A and u_B. This voltage is displayed on the multimeter. Obviously, if the two potentiometers are in the same position the difference voltage $u_B - u_A$ will be zero, and the meter will read mid-scale (assuming that full-scale corresponds to the full supply voltage).

If player 'A' now 'runs away', turning his knob in such a way that u_A decreases, the pointer will move to the right. Player 'B', seeing this, counters by twisting his knob in the same direction, causing the pointer to swing back toward mid-scale.

A further optical indication is provided by means of two LEDs. The voltage u_M is fed to a 'window comparator'. This part of the circuit is discussed in detail elsewhere in this issue (see 'Pocket Bagatelle'). For the present application it is sufficient to know that the output voltage u_C from the window comparator is logic zero as long as the input voltage u_M remains within the voltage 'window', and becomes logic 'one' as soon as u_M is outside the 'window'. In other words, since the voltage window is a small range around half supply voltage, u_C is logic zero as long as the pointer reads approximately mid-scale, and becomes logic 1 if the pointer moves out of this area. As soon as this happens, a LED lights ('escaped'). If player 'A' succeeds in catching 'B' again, the LED will extinguish. If 'A' can now 'hold on to' player 'B' for a sufficient length of time (determined by an RC-network) a different LED will light: 'Gotcha!'

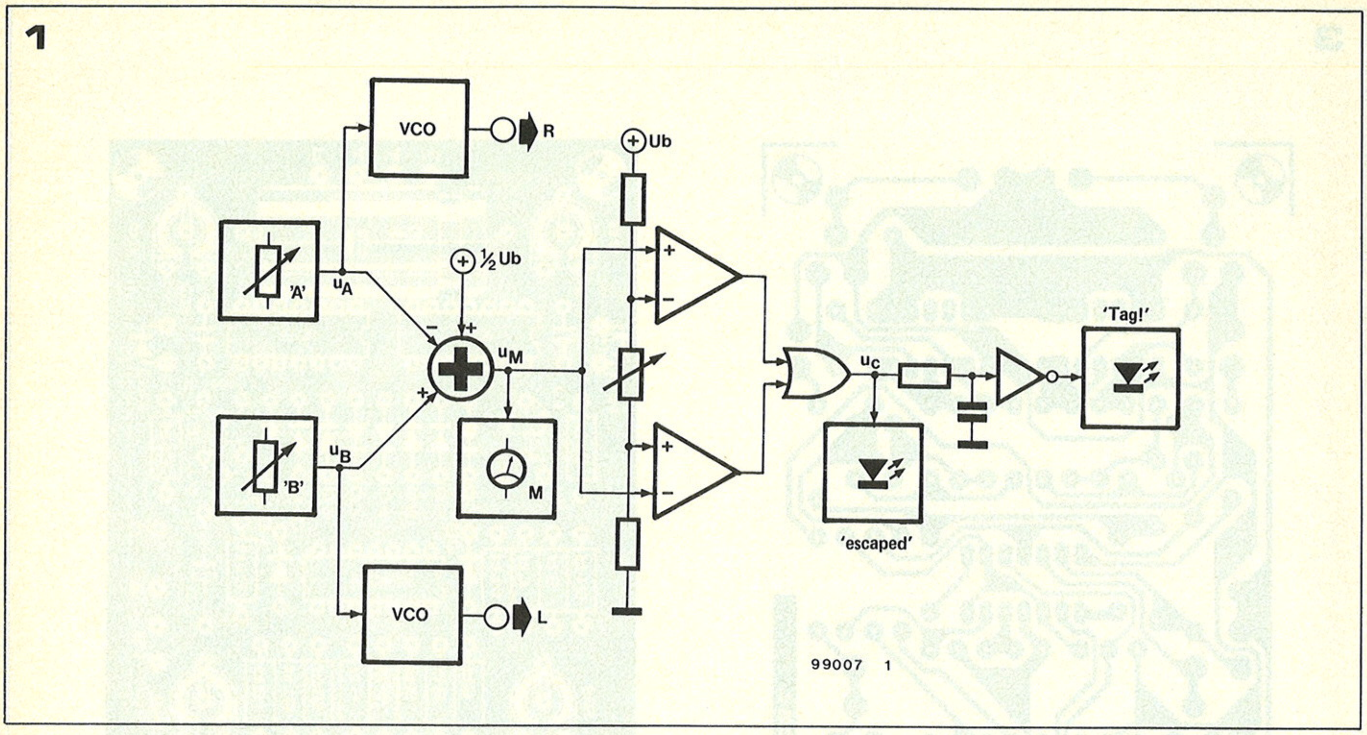
The two VCO's are driven direct from the player control voltages, u_A and u_B. If the outputs from these oscillators are fed to the two channels of a stereo amplifier, an audible indication is obtained of the positions of the two controls. If 'A' has caught 'B' — in other words, if the control voltages are equal — the tones produced by the two VCO's will also be (almost) the same.

The circuit

Having understood the basic principles, the circuit itself (figure 2) is fairly straightforward. P1 and P2 are the player controls. The voltages at the wipers can be varied between approximately 3 V and 9 V. The two voltages are fed to the differential amplifier A1. Half the supply voltage ($½U_b$) is available at the R7/R8 junction, and this reference voltage is also fed in at this point.

The output from A1 is the voltage u_M, also shown in the block diagram. The pointer instrument is connected to this point. Two options are available, a built-in milliameter or a normal multimeter, as will be discussed later. The same voltage is also fed to the window comparator, consisting of A2 and A3. The width of the window can be set with P3 ('handicap'). Obviously, a wide window makes it easier to catch the opponent,

1



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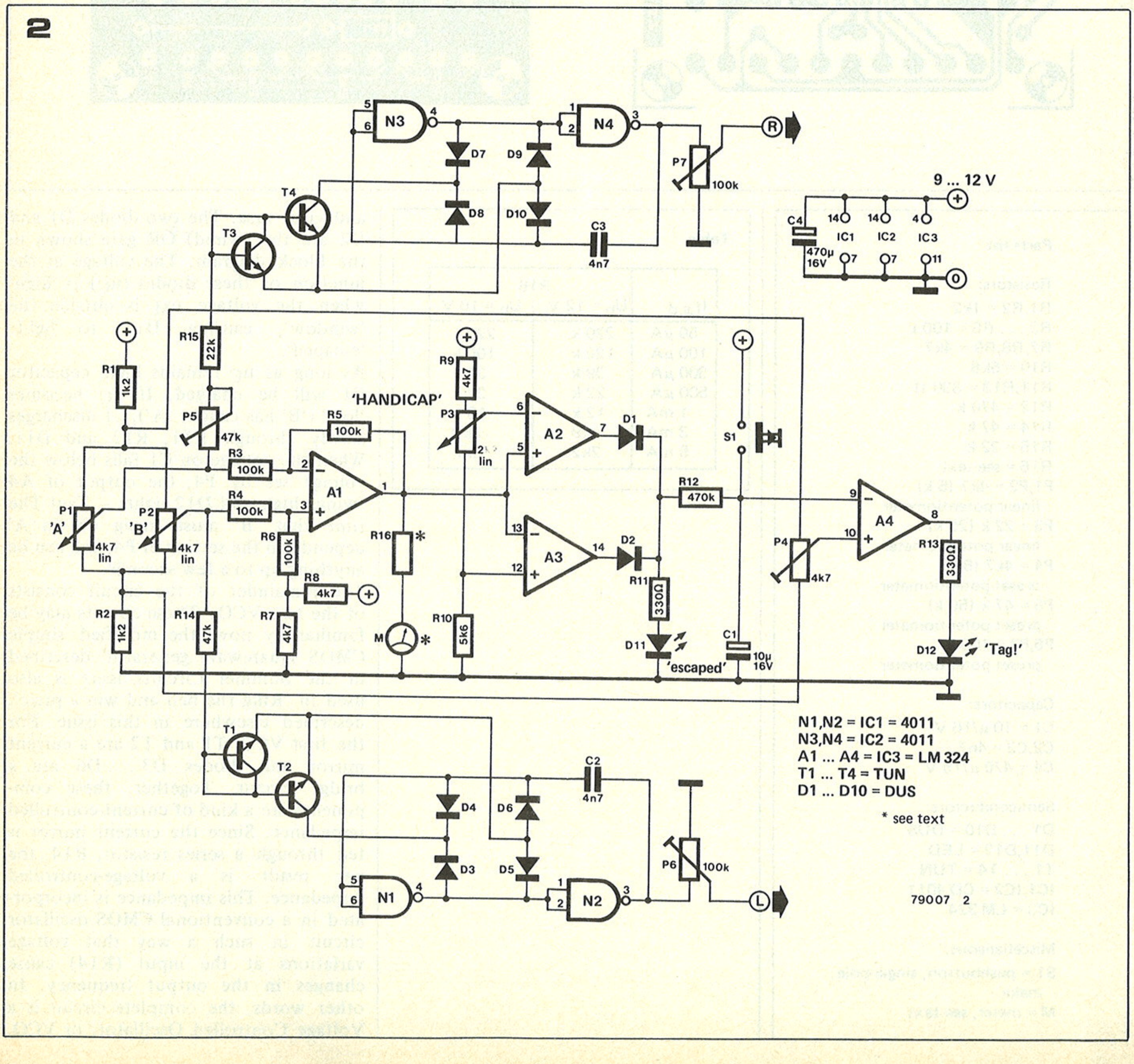
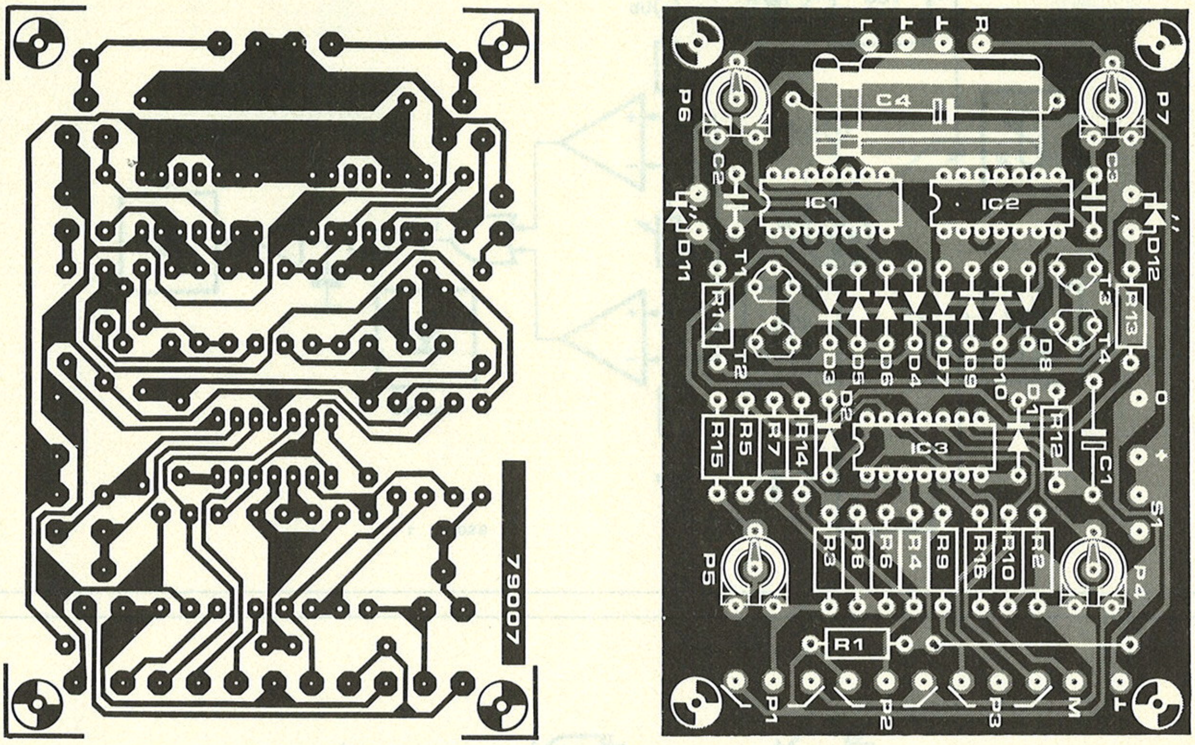


N1,N2 = IC1 = 4011
N3,N4 = IC2 = 4011
A1 ... A4 = IC3 = LM 324
T1 ... T4 = TUN
D1 ... D10 = DUS

* see text

3



Parts list

Resistors:
R1,R2 = 1k2
R3 . . . R6 = 100 k
R7,R8,R9 = 4k7
R10 = 5k6
R11,R13 = 330 Ω
R12 = 470 k
R14 = 47 k
R15 = 22 k
R16 = see text
P1,P2 = 4k7 (5 k)
linear potentiometer
P3 = 22 k (25 k)
linear potentiometer
P4 = 4k7 (5 k)
preset potentiometer
P5 = 47 k (50 k)
preset potentiometer
P6,P7 = 100 k
preset potentiometer

Capacitors:
C1 = 10 µ/16 V
C2,C3 = 4n7
C4 = 470 µ/16 V

Semiconductors:
D1 . . . D10 = DUS
D11,D12 = LED
T1 . . . T4 = TUN
IC1,IC2 = CD 4011
IC3 = LM 324

Miscellaneous:
S1 = pushbutton, single-pole, make
M = meter, see text

Table

$I_{f.s.d.}$	R16 U_b = 12 V	 U_b = 10 V
50 µA	220 k	220 k
100 µA	120 k	100 k
300 µA	39 k	33 k
500 µA	22 k	22 k
1 mA	12 k	10 k
3 mA	3k9	3k3
5 mA	2k2	2k2

and vice versa. The two diodes D1 and D2 are the (wired) OR gate shown in the block diagram. The voltage at the junction of these diodes (u_C) is 'high' when the voltage u_M is outside the 'window', causing D11 to light: 'escaped'.

As long as u_C remains high, capacitor C1 will be charged. If u_C becomes 'low' ('B' has caught 'A'), C1 discharges slowly through R11, R12 and D11. When the voltage on C1 falls below the voltage set by P4, the output of A4 swings high and D12 lights – Tag! The time that 'B' must 'hang on to A' depends on the setting of P4, and can be anything up to a few seconds.

The remainder of the circuit consists of the two VCOs. These circuits may be familiar by now: the modified 'simple CMOS squarewave generator' described in the Summer Circuits issue is also used in 'Ring the bell and win a prize', described elsewhere in this issue. For the first VCO, T1 and T2 are a current mirror and diodes D3 . . . D6 are a bridge circuit. Together, these components are a kind of current-controlled impedance. Since the current mirror is fed through a series resistor, R14, the net result is a voltage-controlled impedance. This impedance is incorporated in a conventional CMOS oscillator circuit in such a way that voltage variations at the input (R14) cause changes in the output frequency. In other words, the complete circuit is a Voltage Controlled Oscillator, or VCO.

4

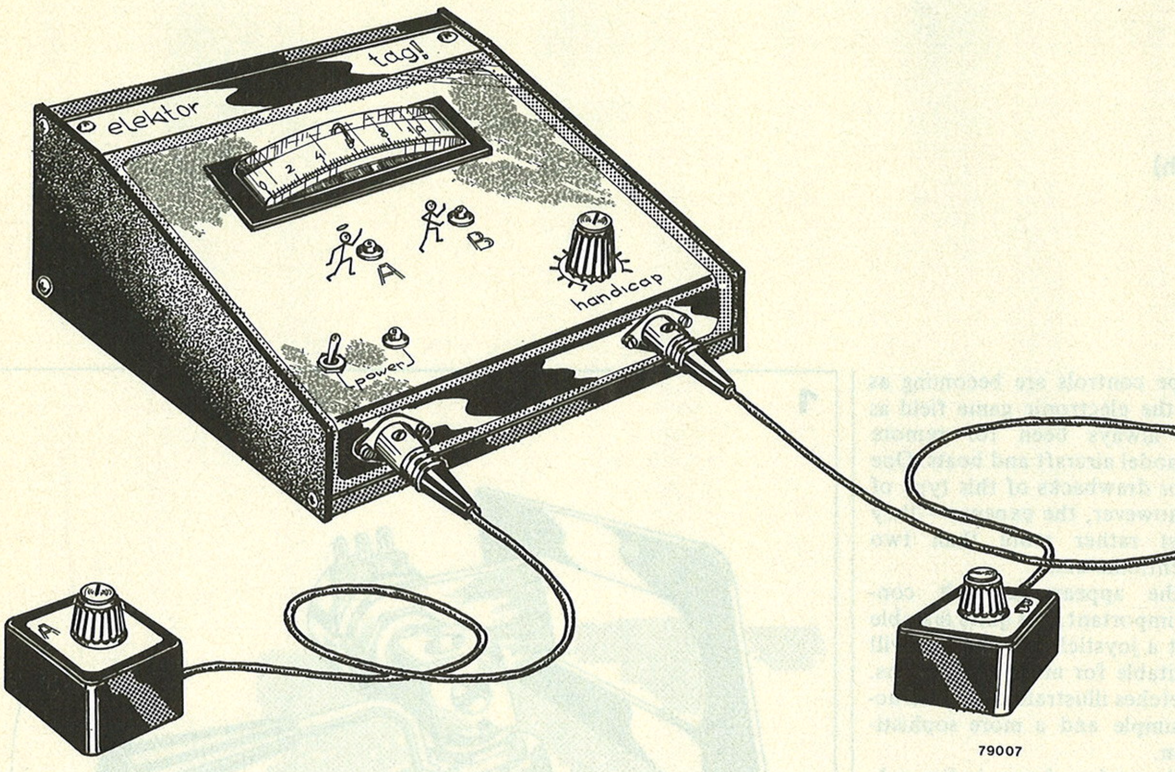


Figure 3. Printed circuit board and component layout (EPS 79007).

Figure 4. The only really important thing about the case is that it should be strong enough! The controls could also be mounted in the main case, but this usually proves awkward unless one of the players happens to be left-handed.

The output level from this oscillator can be set with P6. The second VCO is basically identical, with one minor exception: preset potentiometer P5 is included, so that the 'tracking' of the two oscillators can be adjusted.

Construction

A printed circuit board design and corresponding component layout are shown in figure 3. Although only four NAND gates are used in the circuit, use of a single quad NAND gate IC proved unsatisfactory: the two oscillators tended to 'bite each other'. For this reason, two IC's are used, one for each VCO.

As far as the meter M is concerned, there is a wide range of options. Micro- or milliameters with any sensitivity between 50 μA and 5 mA f.s.d. can be used. In this case, the value of the series resistor R16 is chosen so that the meter reads full scale when the full supply voltage is connected across the series-connection of meter and resistor. The value of the resistor should be approximately:

$$R_{16} = \frac{U_b}{I_{f.s.d.}} \quad (k\Omega),$$

where U_b is in volts and $I_{f.s.d.}$ (the full-scale sensitivity of the meter) is in milliamps. In the interest of saving the batteries in thousands of pocket calculators around the world, the Table lists values for R16 for several common full-scale sensitivities and for two supply voltages. The nearest standard value has been chosen in each case – the meter doesn't have to be a precision instrument!

If a multimeter is available there is no real need to invest in a new meter for this circuit – unless, of course, one is afraid to let that expensive item fall into the hands off one's offspring. If a multimeter *is* to be used, R16 can be replaced by a 1 k resistor – just in case of accidental shorts – and the supply voltage is chosen equal to a suitable voltage range on the meter (10 V f.s.d., for instance).

It is advisable to mount this type of circuit in a sturdy case. The players are liable to get highly excited! Figure 4 is just one possible suggestion. In this case, the two controls are mounted separately and connected to the main unit by means of a standard three-core (mains) cable.

joysticks

(G. Wünsch)

Joystick-type controls are becoming as popular in the electronic game field as they have always been for remote control of model aircraft and boats. One of the major drawbacks of this type of control is, however, the expense – they usually cost rather more than two normal potentiometers!

Provided the appearance isn't considered too important, it is quite feasable to construct a joystick control that will be quite suitable for most applications. The two sketches illustrate the construction of a simple and a more sophisticated version.

In the simple version shown in figure 1, the two potentiometer spindles are joined at right-angles. This can, of course, be done in several ways; using a block of brass or plastic with holes drilled in it, as shown, is probably as good as any. One of the potentiometers is mounted on a stand; the other is fastened to a control lever.

The more sophisticated version, shown in figure 2, works on the same basic principle: two normal potentiometers joined at right-angles. However, in this case two springs are included to return the control lever to neutral. The construction is, understandably, more complicated.

One of the potentiometers is mounted on a base-plate. A metal (or plastic) right-angle is mounted on the spindle. A spring is looped round the potentiometer spindle, with its open ends resting against a bolt. A longer bolt, mounted on the right-angle, engages the spring in such a way that the spring acts to centre the right-angle – and, with it, the potentiometer. Two further bolts, mounted on the base-plate, serve as end stops (the height of sophistication!). The second potentiometer is mounted on the second flange of the right-angle. The control lever is mounted on its spindle, with a similar spring-and-bolts construction to centre it.

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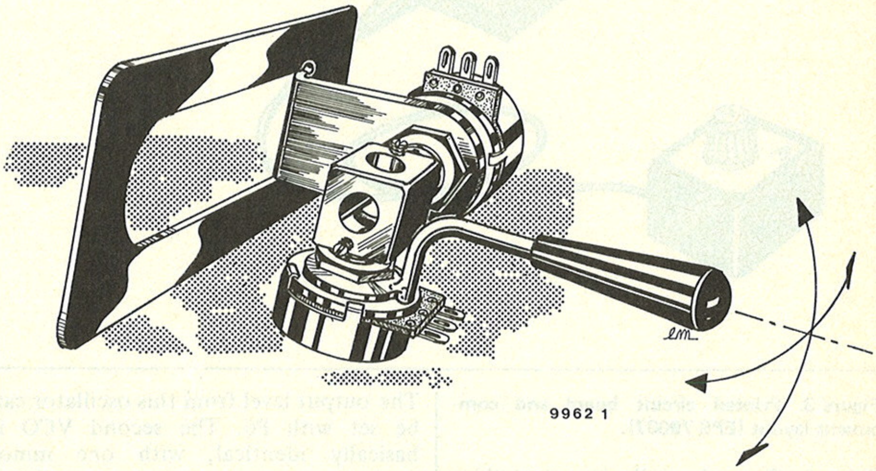

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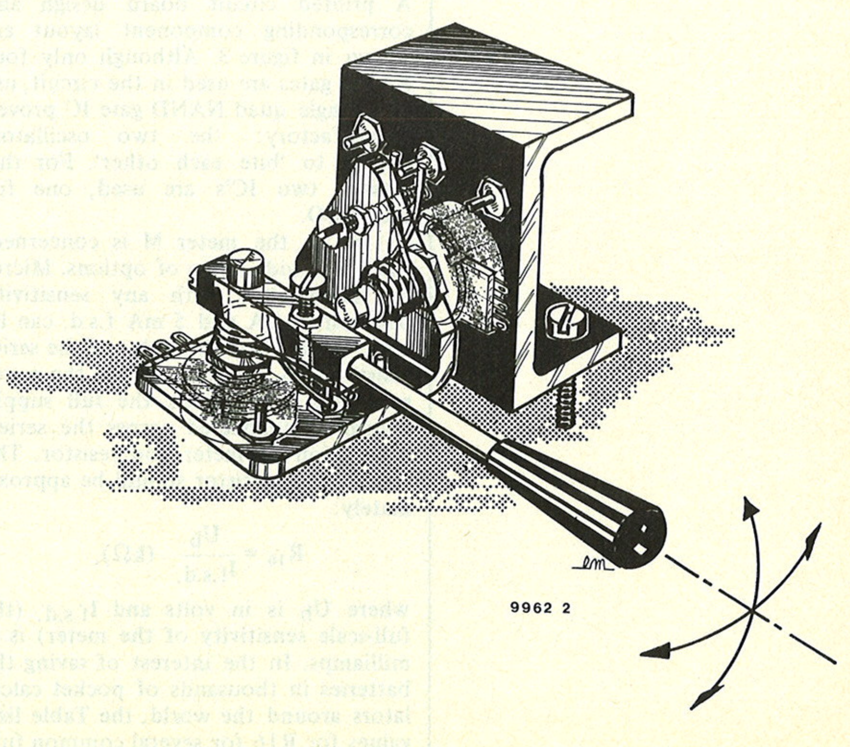


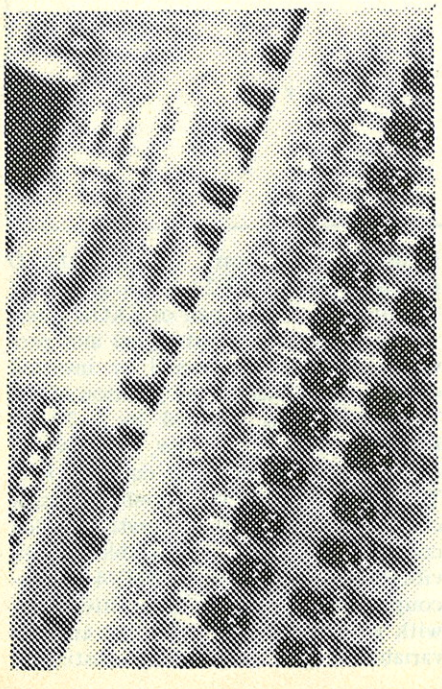
9962 2

digiscope

For examining pulse trains in digital circuits an oscilloscope is an invaluable aid. However, oscilloscopes are expensive, and furthermore the analogue display capability of a conventional 'scope is rarely required in digital circuits, since only two voltage states, corresponding to logic 0 and 1, are encountered.

The Digiscope offers a low-cost alternative to the conventional oscilloscope for digital work, and displays digital pulse trains on two rows of light-emitting diodes.

E. Muller



The principle of the Digiscope is illustrated in figure 1. The digital waveform to be displayed is sampled at a number of points and the value of the waveform at the instant of each sample (logic 0 or 1) is stored in a number of latches (flip-flops). The Q and $\overline{Q}$ outputs of the latches are connected to two rows of LEDs, the upper row indicating logic 1 and the lower row indicating logic 0. The pattern displayed by the two rows of LEDs will thus correspond to the digital waveform.

This is shown in figure 1, where a digital waveform is shown together with the corresponding display on the Digiscope. Any number of samples can be taken, and obviously the greater the number of samples per cycle of the waveform the more accurate will be the resulting display. However, the cost factor must be considered, since each sample requires a flip-flop and two LEDs, and a reasonable compromise of 16 flip-flops and 32 LEDs was adopted.

Block diagram

Figure 2 shows the block diagram of the Digiscope. The memory consists of 16 D flip-flops. A 'timebase' consisting of a clock oscillator, 4-bit counter and 1-of-16 decoder 'scans' the memory, i.e. takes the clock input of each flip-flop high in turn. The input signal is connected to the D inputs of all the flip-flops, so that if the input is high when the clock input of a particular flip-flop is activated then the Q output of that flip-flop will go high. Conversely, if the input signal is low then the output of the flip-flop will remain low. The scanning of the memory by the timebase is analogous to the spot sweeping across the screen of a conventional oscilloscope, hence the term 'timebase' is used for this function.

Like the timebase of a conventional oscilloscope, the timebase of the Digiscope has coarse and fine speed controls. Fine speed control is effected by varying the frequency of the clock generator between 100 kHz and 500 kHz, whilst coarse speed control is effected by preceding the 4-bit counter by a variable frequency divider, whose division ratio can be varied from 1 to 1000 in steps of 1, 2, 5, 10, 20 . . . etc., just like a conventional oscilloscope. The timebase speed range is from 4 µs per LED i.e. 64 µs for a single scan of the complete display, to 20 ms per LED, i.e. 320 ms to scan the display.

Trigger circuit

In addition to a timebase with a wide speed range it is also important to have a reliable trigger circuit. When the digiscope is used to display repetitive pulse trains the trigger circuit ensures that each timebase sweep starts at the same point in successive pulse trains. If the timebase were not synchronised to the display in this manner then the display would appear to run in one direction or the other depending on the relative speeds of the timebase and the input signal. In addition to being triggered by the input signal the timebase may also be triggered by an external signal or allowed to free run.

Complete circuit

In order to keep the circuit as simple and cheap as possible it was decided to base the design on the 74-series TTL logic family, since this logic family is readily obtainable, inexpensive, can operate at high speeds and is capable of supplying sufficient current to drive LEDs directly. The full circuit diagram of the Digiscope is given in figure 3.

It should be noted that as it stands in figure 3, the Digiscope operates only with TTL logic. However, with the addition of one 4050 CMOS IC, being used as a level converter interface, it can be used with CMOS. The 4050 should be powered by the 5 V supply in the Digiscope, this will allow CMOS

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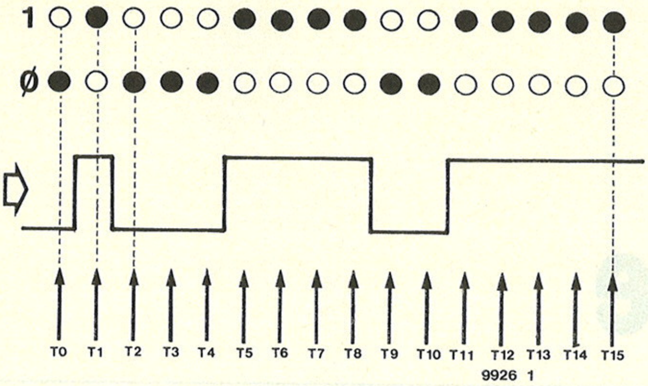

Figure 1. This diagram illustrates the principle of the Digiscope.

Table 1

S7		Approximate maximum timebase speed sec/LED (P1 = 0 Ω)	
position %	1000	4	msec/LED
%	500	2	msec/LED
%	200	800	µsec/LED
%	100	400	µsec/LED
%	50	200	µsec/LED
%	20	80	µsec/LED
%	10	40	µsec/LED
%	5	20	µsec/LED
%	2	8	µsec/LED
%	1	4	µsec/LED

Table 1. Listing of the timebase ranges for each position of the timebase switch.

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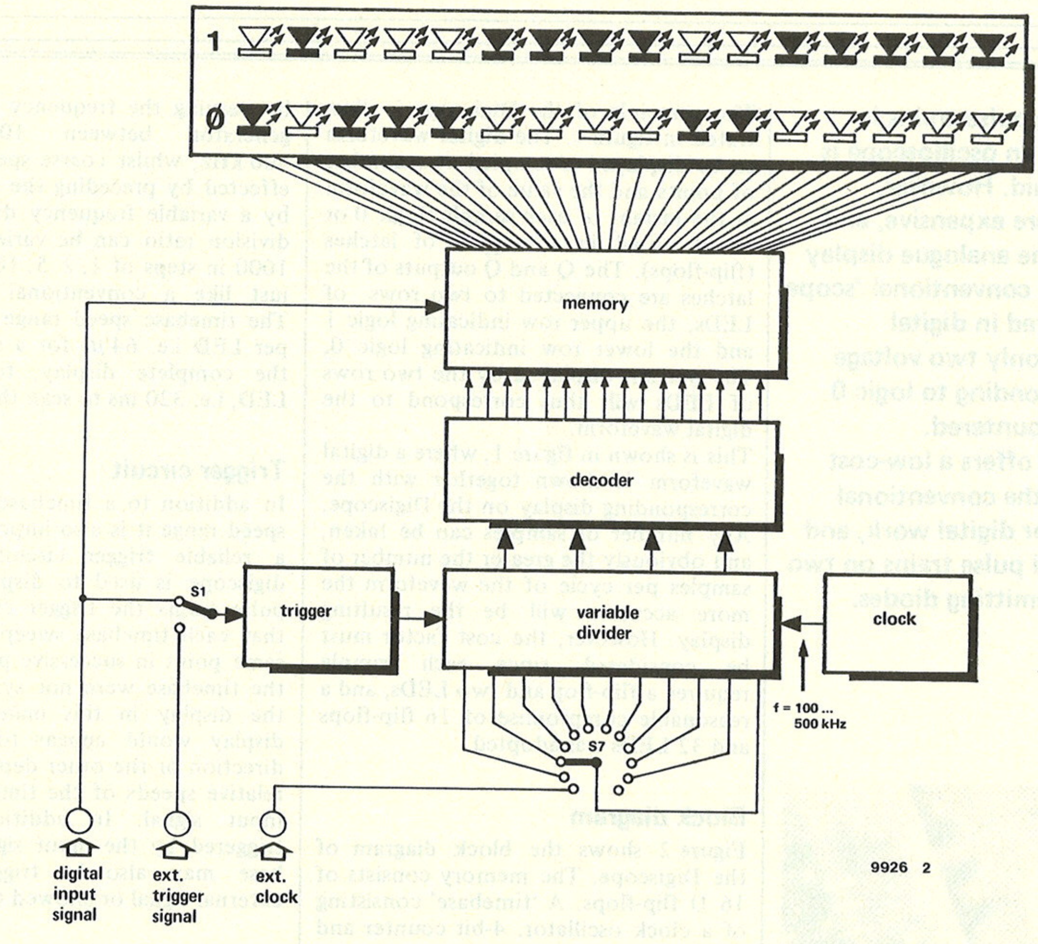

Figure 2. Block diagram of the Digiscope.

circuits with a suplly voltage of up tc about 15 V to be tested.
Since there are 6 buffer amps in one 4050, it can also be used for level conversion of the 'clock input', and 'trig. input'. Since the 4050 can only drive 2 TTL loads, it is advisable to connect 2 of the buffer amps in the 4050 parallel, since the input loading of the Digiscope is 3.

The display memory consists of 16 D flip-flops contained in 8 7474 dual D flip-flop packages, IC11 to IC18. Since the D inputs of these flip-flops present a total of 16 TTL loads and a normal TTL output can drive only 10 TTL loads it is necessary to drive the D inputs of FF7 to FF22 in two groups of 8. This is done by a pair of EXOR gates, which buffer the input signal and provide a choice of normal or inverted display depending on the position of S9. The memory is scanned by a 74154 binary to 1-of-16 decoder, IC10, which is driven by the four-bit counter, IC7. The remainder of the timebase circuit comprises the clock generator (which consists of two monostable multivibrators, MMV3 and MMV4, cross-coupled to form an astable multivibrator with good frequency stability) and the variable frequency divider consisting of

Figure 3. Complete circuit of the Digiscope. Resistors R29a, b, c and d can, of course, be replaced by a single resistor (R29) as on the p.c. board.

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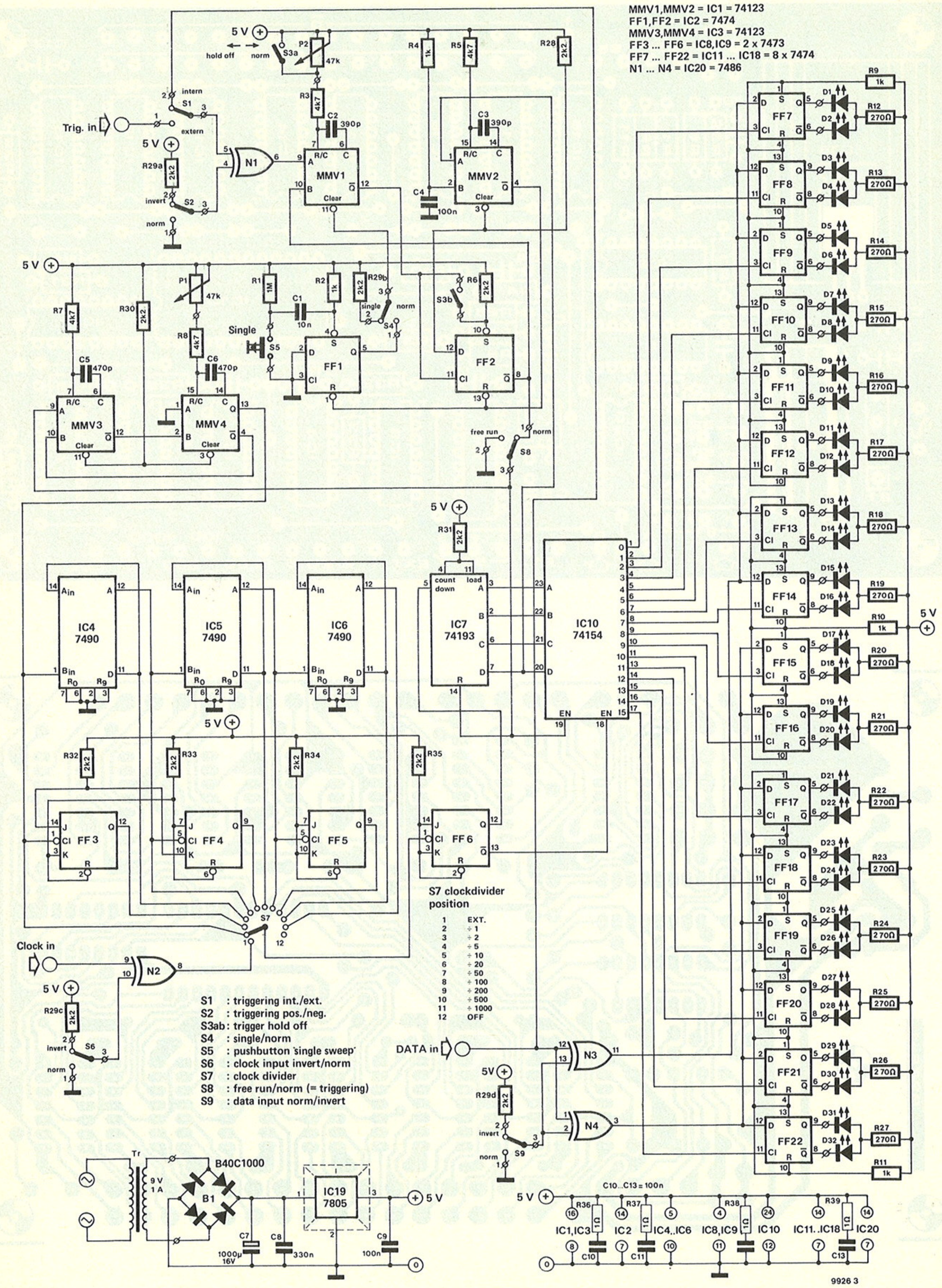

MMV1,MMV2 = IC1 = 74123
FF1,FF2 = IC2 = 7474
MMV3,MMV4 = IC3 = 74123
FF3 ... FF6 = IC8,IC9 = 2 x 7473
FF7 ... FF22 = IC11 ... IC18 = 8 x 7474
N1 ... N4 = IC20 = 7486

S7 clockdivider position

1	EXT.
2	÷ 1
3	÷ 2
4	÷ 5
5	÷ 10
6	÷ 20
7	÷ 50
8	÷ 100
9	÷ 200
10	÷ 500
11	÷ 1000
12	OFF

S1 : triggering int./ext.
S2 : triggering pos./neg.
S3ab: trigger hold off
S4 : single/norm
S5 : pushbutton 'single sweep'
S6 : clock input invert/norm
S7 : clock divider
S8 : free run/norm (= triggering)
S9 : data input norm/invert

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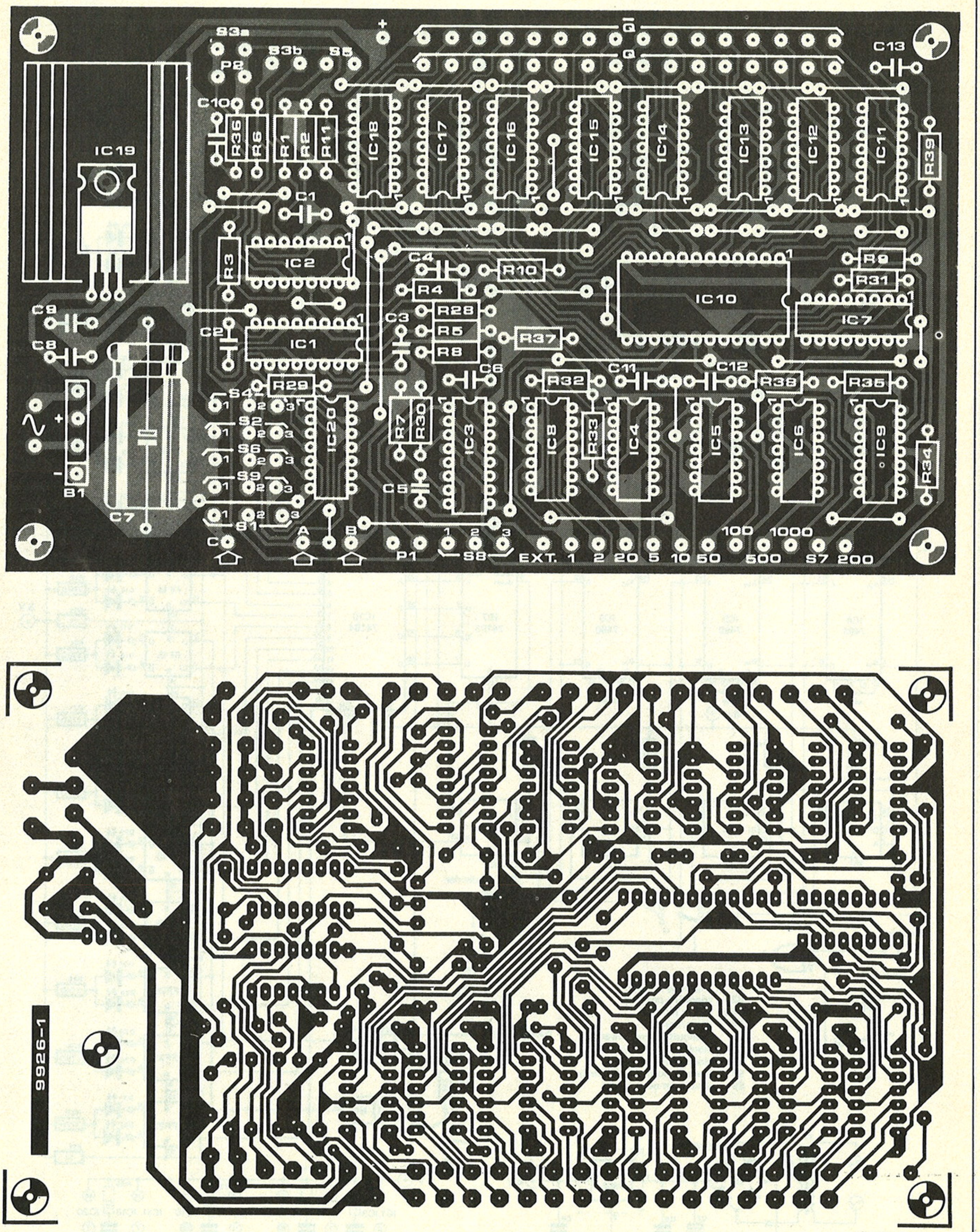
S3a
P2
S3b
S5
+
Q̄
Q
C13
C10
R36
R6
R1
R2
R11
IC18
IC17
IC16
IC15
IC14
IC13
IC12
IC11
R39
IC19
C1
R3
IC2
C4
R10
R9
R31
R4
R28
R5
R8
IC10
IC7
C9
C8
C2
IC1
C3
R37
C6
C11
C12
R29
R32
R38
R35
S4
S2
S6
S9
S1
~
+
-
B1
C7
IC20
R7
R30
IC3
IC8
R33
IC4
IC5
IC6
IC9
R34
C5
C
A
B
P1
1 2 3
S8
EXT. 1 2 20 5 10 50 100 500 1000 S7 200
9926-1

parts list to figures 3, 4 and 5

Resistors:
R1 = 1 M
R2,R4,R9,R10,R11 = 1 k
R3,R5,R7,R8 = 4k7
R6,R28 . . . R35 = 2k2
R12 . . . R27 = 270 Ω
R36 . . . R39 = 1 Ω
P1,P2 = 47 k

Capacitors:
C1 = 10 n
C2,C3 = 390 p
C4,C9 . . . C13 = 100 n
C5,C6 = 470 p
C7 = 1000 μ/10 V
C8 = 330 n

Semiconductors:
IC1,IC3 = 74123
IC2,IC11 . . . IC18 = 7474
IC4,IC5,IC6 = 7490
IC7 = 74193
IC8,IC9 = 7473
IC10 = 74154
IC19 = 7805
IC20 = 7486
D1 . . . D32 = LED
B1 = B 40 C 1000 (40 V/1 A
bridge rectifier)

Miscellaneous:
S1,S2,S4,S6,S8,
S9 = switch SPDT
S3 = switch DPDT
S7 = switch single pole 11
(12-)-way transformer at
least 9 V/1 A

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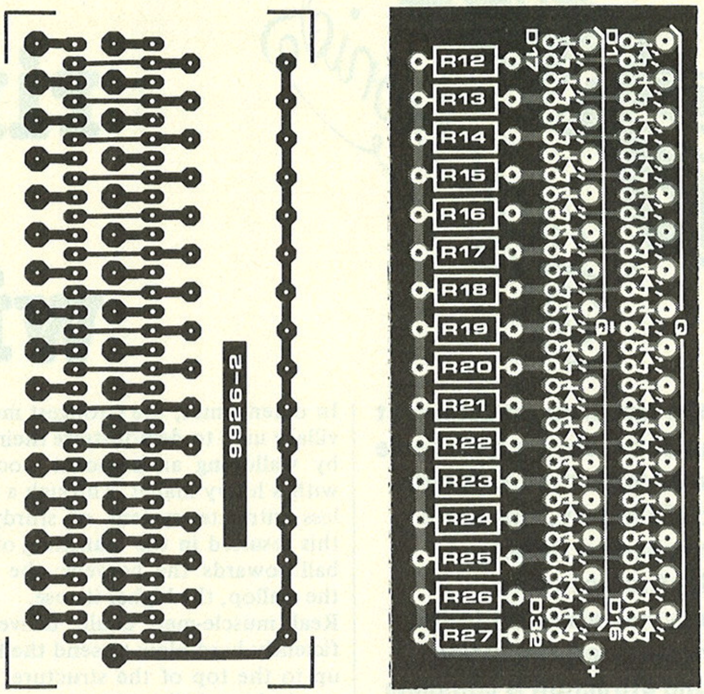

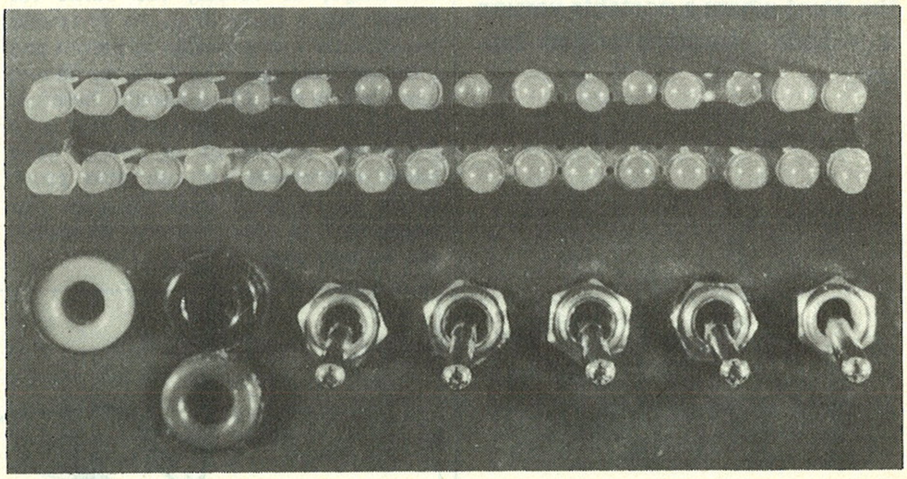

counters IC4 to IC6 and flip-flops FF3 to FF6. The ranges covered by the timebase switch are listed in table 1. An external clock signal may also be fed in via EXOR gate N3 in normal or inverted form.

The trigger circuit comprises monostables IC1 and flip-flops IC2, and offers a variety of triggering modes. S1 offers a choice of internal or external triggering, whilst S2 selects between normal and inverted trigger signal. By switching S4 to the single-shot mode the timebase can be triggered manually by pressing S5. S3 can be used to switch to 'hold-off', in which mode the trigger pulse can be delayed for a variable period. Finally, the trigger circuit can be inhibited and the timebase allowed to run continuously by switching S8 to the 'free-run' position.

Figure 4. Printed circuit board and component layout for the Digiscope, excluding the display section (EPS 9926-1).

Figure 5. Printed circuit board and component layout for the display section of the Digiscope (EPS 9926-2).

Power supply

The Digiscope requires a stabilised 5 V power supply. The circuit of a suitable supply consisting of a transformer, bridge rectifier, reservoir capacitor and an IC regulator is also shown in figure 3.

Construction

The complete circuit of the Digiscope is mounted on two printed circuit boards. The p.c. board whose layout is shown in figure 4 accommodates all the logic circuits and the power supply, with the exception of the mains transformer, whilst the display is mounted on the board whose layout is given in figure 5. This should be connected to the main board using a 33-core ribbon cable or something similar. ◆

ring the bell and win a prize!

One of the favourite attractions at fair-grounds has always been some variation of 'bash-the-block-with-a-mallet'. Originally, this was a purely mechanical device, although of recent years technology has advanced to the stage where no self-respecting fair-ground attraction is complete without a dazzling display of flashing lights. However, electronics have now progressed to the point where a portable version is possible – suitable for desk-top use.

In olden times, the strongest men in the village used to demonstrate their prowess by walloping an innocent wooden peg with a heavy mallet. Through a more-or-less intricate system of sturdy levers, this resulted in the launching of a metal ball towards the heavens; the mightier the wallop, the higher it rose.

Real muscle-men could deliver a sufficiently hard blow to send the ball right up to the top of the structure, where it would hit a bell with an almighty clang. This won them a prize and, more importantly, the esteem of all those who witnessed the feat.

Nowadays, of course, the battle for superiority is more likely to be fought out indoors – specifically, at parties and business meetings. The desk-top model described in this article should therefore fulfil a major need. Operated as it is by fist-power instead of by means of a blunt instrument, it can also prove useful as an ideal 'fury-indicator' for managers. In fact, every executive should have one.

The circuit

Before even starting to design the circuit, a suitable force sensor must be found. This should not only be sufficiently sturdy; it should also be reasonably cheap and readily available. The solution chosen may be somewhat inelegant, but it has proved highly satisfactory in practice.

The sensor consists of a piece of conductive foam plastic, of the type currently in use for packing CMOS IC's. The specific resistance of this foam drops dramatically when the foam is compressed – this is not particularly surprising, in view of the fact that the carbon particles in the foam become more tightly packed as the volume decreases. Remember the carbon mike?

The mechanical construction is shown in figure 1. The foam is placed between two metal plates (with wires attached) and this 'sandwich' is placed in a suitable wooden holder. A two-piece wooden block serves to spread the force

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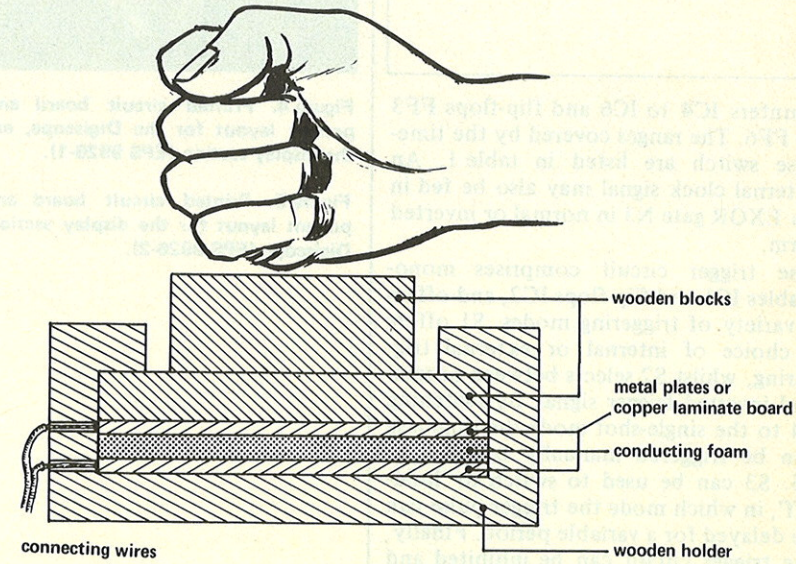

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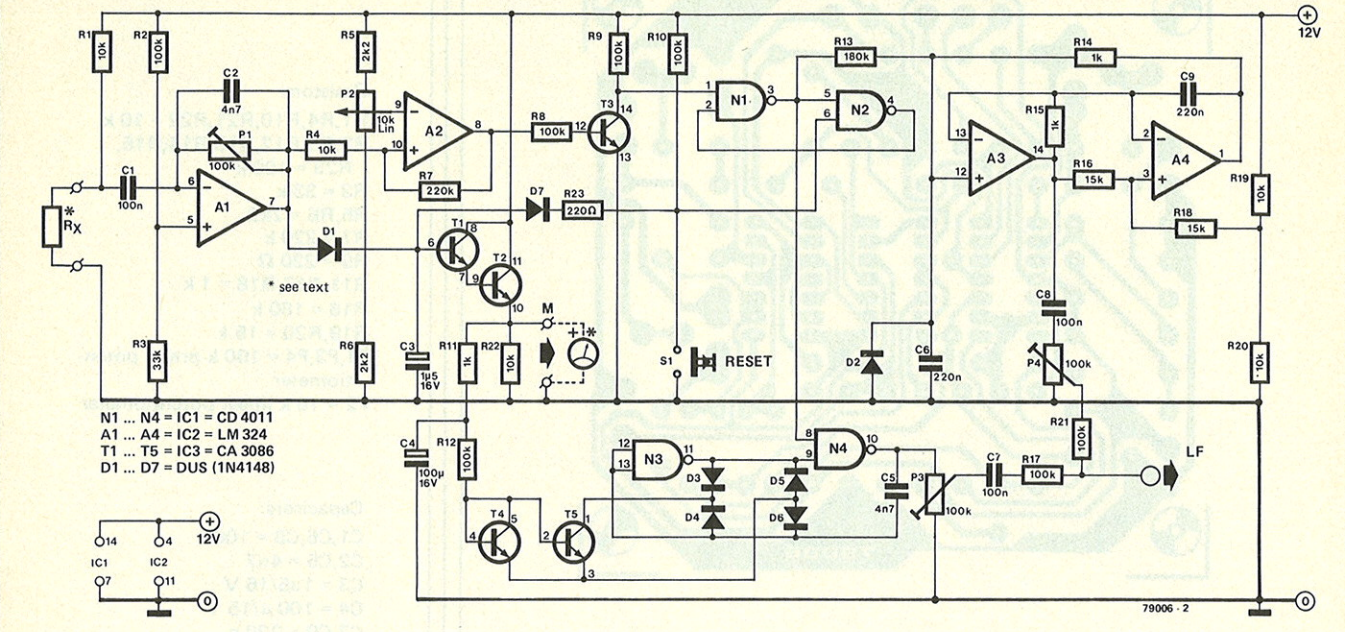

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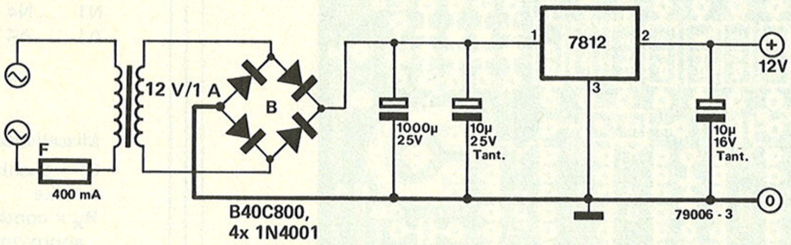


Figure 1. The sensor consists basically of conducting foam, sandwiched between two metal plates and mounted in a wooden box. Copper laminate board can, of course, be used instead of the metal plates.

Figure 2. Complete circuit for 'Ring the bell and win a prize'.

Figure 3. A suitable 12 V power supply.

of the blow evenly over the upper metal plate. For most ordinary mortals, with the possible exception of karate experts, it is advisable to glue some softer material over the upper surface of the target area – hitting a solid wooden block with the bare hand, hard, is not everybody's idea of fun!

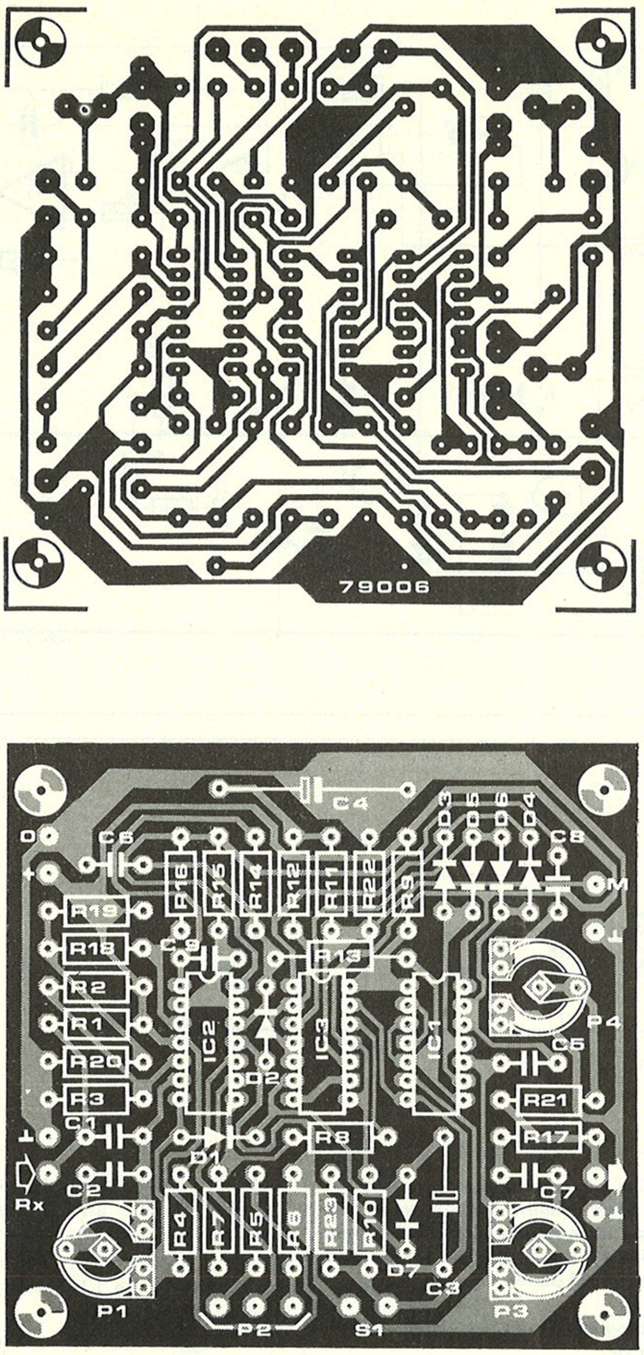
Having settled the details of the sensor, it can now be reduced to a small rectangle marked R_X and included in the circuit shown in figure 2. The sensor, R_X, and R1 together form a potential divider. A sudden change in the resistance R_X causes a sudden jump in the voltage at the R_X/R1 junction. This voltage 'spike' is passed through C1 to the input of opamp A1. The gain of this amplifier stage can be preset by means of P1, to suit the characteristics of the sensor and the (expected) strength of the potential customers. The output from A1 (a positive-going spike) is passed to a peak detector and to a trigger circuit.

The peak detector consists of D1 and C3. The highest voltage level appearing at the output of A1 as a result of a blow on the sensor is 'stored' in C3. This voltage is buffered by the super-emitter-follower T1/T2 and is available as the output voltage U_p. It can be used to drive a pointer instrument (e.g. an AVOmeter) or a LED voltmeter, as will be described later.

The trigger circuit consists of A2, R4 . . . R7 and P2. The trigger threshold (and thus the strength of the blow required to 'score') can be set with P2. The output from A2 is fed, via T3, to a set/reset (RS) flip-flop consisting of N1 and N2. This flip-flop controls the 'ding' generator, A3/A4, which is derived from the 'electronic gong' (see the 'Summer Circuits' 1978 issue, circuit no. 13). The output can be fed, via P4, to a power amplifier; if a suitably 'hefty' amplifier and loudspeaker are used, a very gratifying 'bong' will be produced.

To further enhance the audible effect, a VCO (voltage controlled oscillator) is also included. The peak output voltage, U_p, is fed via R11 to C4. C4 will therefore charge up slowly to U_p, causing the VCO (T4, T5, N3, N4 and the associated diodes, resistor and capacitor) to produce a slowly-rising wail. However, the VCO can only operate if the

4



Parts list

Resistors:

R1,R4,R10,R21,R22 = 10 k
R2,R8,R12,R13,R14,R15,
R23 = 100 k
R3 = 33 k
R5,R6 = 2k2
R7 = 220 k
R9 = 220 Ω
R11,R17,R18 = 1 k
R16 = 180 k
R19,R20 = 15 k
P1,P3,P4 = 100 k preset potentiometer
P2 = 10 k linear potentiometer

Capacitors:

C1,C6,C8 = 100 n
C2,C5 = 4n7
C3 = 1µ5/15 V
C4 = 100 µ/15 V
C7,C9 = 220 n

Semiconductors:

T1 . . . T5 = IC3 = CA 3086
D1 . . . D7 = DUS
N1 . . . N4 = IC1 = CD 4011
A1 . . . A4 = IC2 = LM 324

Miscellaneous:

S1 = pushbutton, single-pole, make
R_x = conducting foam plastic, approximately 3" square (7 x 7 cm).

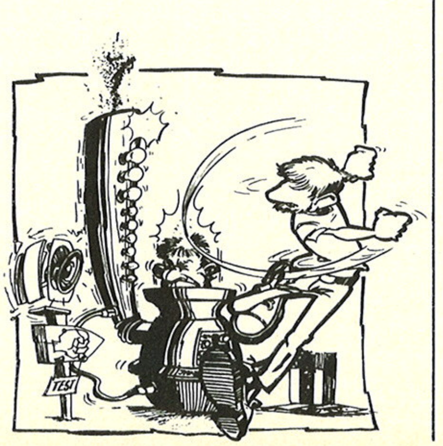
Figure 4. Printed circuit board and component layout for the circuit shown in figure 2 (EPS 79006).

RS flip-flop N1/N2 has been triggered. The circuit can be reset by means of S1: C3 is rapidly discharged and the RS flip-flop is reset.

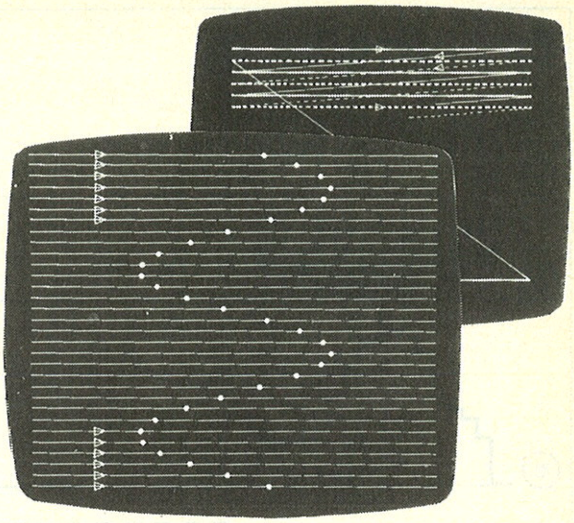
Final notes

The most sensational effect can be obtained by using a LED voltmeter to indicate the U_p output level. A suitable circuit is the 'UAA 180 LED voltmeter' described in Elektor 33, January 1978, p. 1-20.

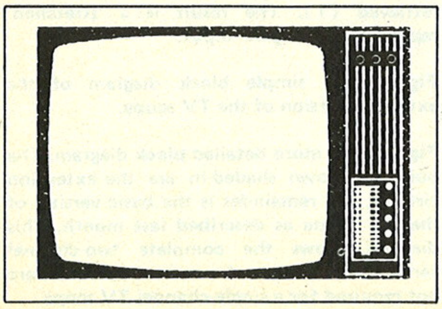
Both the circuit described here and the LED voltmeter will operate on a simple 12 V supply like the one shown in figure 3. ◀



extending the TV-scope



As explained last month, a normal TV set can be used as an oscilloscope. A simple converter for this purpose was described in detail: the 'TV scope - basic version'. In an introductory article it was explained that this basic version could be extended, thereby eliminating its two major weaknesses: limited usefulness at high frequencies and lack of triggering facilities. Before discussing the details of the extension circuits, a fuller explanation of the underlying principles is in order.



The basic version of the TV scope, described last month, can be used to display low-frequency signals on the screen of a domestic TV receiver. This is achieved by sampling the input signal and using each sample to determine the position of a white spot on one line of the final picture. Sync pulses are added to complete the video signal, and an (optional) VHF/UHF modulator is included. The exact details of the circuits were described last month; for the discussion of the extension circuits it is sufficient to consider the basic version as a 'black box' with a low-frequency input and a video (or VHF/UHF) output. The only important technical details for the present are the sampling rate (TV line frequency, i.e. approximately 15 kHz), the fixed timebase frequency (TV frame frequency, i.e. 50 Hz, corresponding to 20 ms) and the lack of triggering facilities.

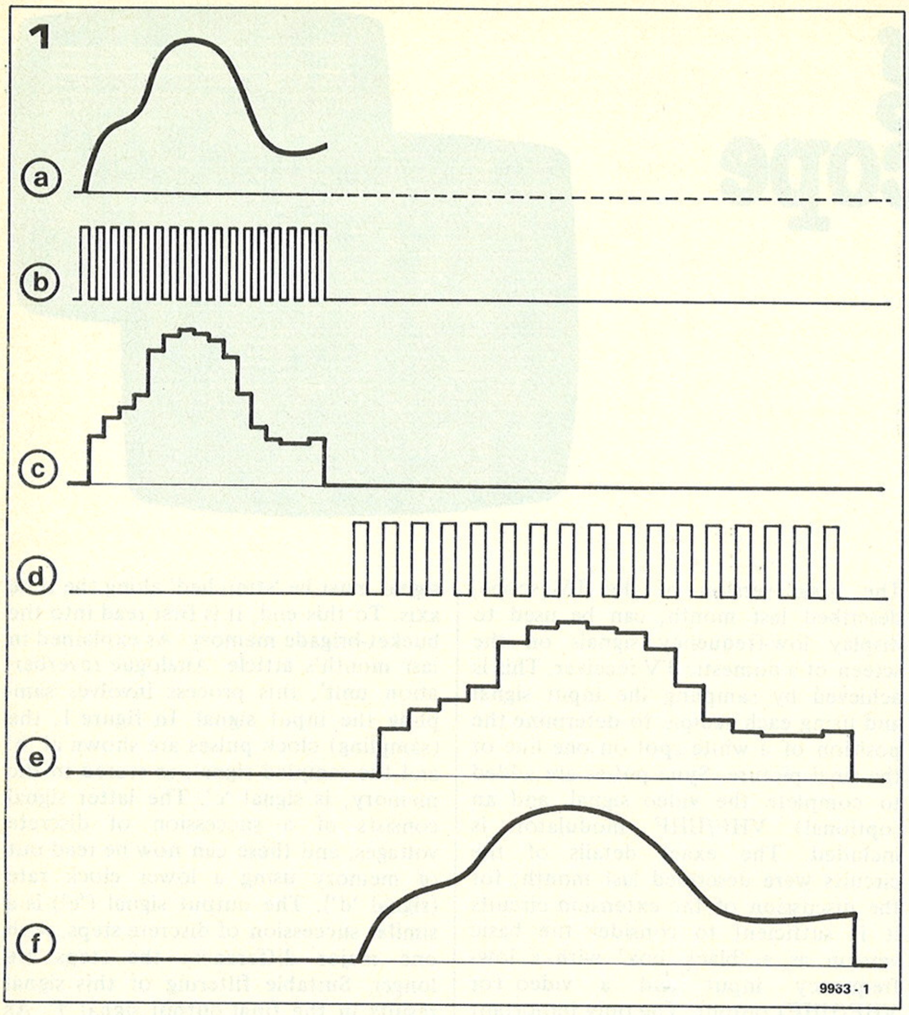
To extend the capabilities of the TV scope, the first priority is to get away from the fixed timebase frequency. Basically, what is required is a timebase expander, that is, a circuit that will 'slow down' a signal to any desired 'speed'. The signal goes in at one end, at high frequency, and comes out at the other with its frequency reduced to a manageable value. In a way, a tape recorder with several tape speeds is equivalent to a timebase expander. If a signal is recorded at, say, 15"/s and then played back at 7½"/s, the frequency of the output signal will be half that of the original. This corresponds to 'timebase expansion'.

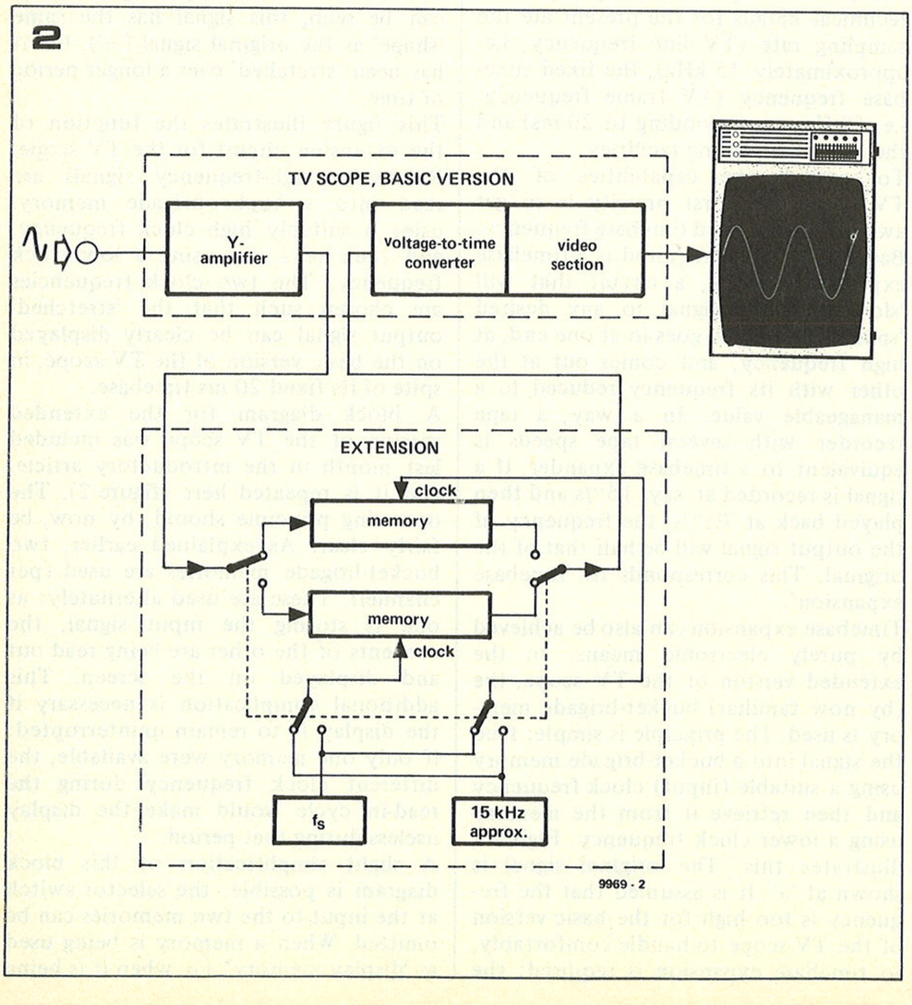
Timebase expansion can also be achieved by purely electronic means. In the extended version of the TV scope, the (by now familiar) bucket-brigade memory is used. The principle is simple: feed the signal into a bucket-brigade memory using a suitable (input) clock frequency and then retrieve it from the memory using a lower clock frequency. Figure 1 illustrates this. The original signal is shown at 'a'. It is assumed that the frequency is too high for the basic version of the TV scope to handle comfortably, so timebase expansion is required: the signal must be 'stretched' along the time axis. To this end, it is first read into the bucket-brigade memory. As explained in last month's article 'Analogue reverberation unit', this process involves sampling the input signal. In figure 1, the (sampling) clock pulses are shown at 'b' and the sampled signal, as stored in the memory, is signal 'c'. The latter signal consists of a succession of discrete voltages, and these can now be read out of memory using a lower clock rate (signal 'd'). The output signal ('e') is a similar succession of discrete steps, with one major difference: the steps are longer. Suitable filtering of this signal results in the final output signal 'f'. As can be seen, this signal has the same 'shape' as the original signal ('a'), but it has been 'stretched' over a longer period of time.

This figure illustrates the function of the extension circuit for the TV scope. Relatively high-frequency signals are read into a bucket-brigade memory, using a suitably high clock frequency, and then read out using a low clock frequency. The two clock frequencies are chosen such that the 'stretched' output signal can be clearly displayed on the basic version of the TV scope, in spite of its fixed 20 ms timebase.

A block diagram for the extended version of the TV scope was included last month in the introductory article, and it is repeated here (figure 2). The operating principle should, by now, be fairly clear. As explained earlier, two bucket-brigade memories are used (per channel). These are used alternately: as one is storing the input signal, the contents of the other are being read out and displayed on the screen. This additional complication is necessary if the display is to remain uninterrupted: if only one memory were available, the different clock frequency during the read-in cycle would make the display useless during that period.

A slight simplification of this block diagram is possible: the selector switch at the input to the two memories can be omitted. When a memory is being used as 'display memory', i.e. when it is being





read out, any new signal entered into it will remain unused – it will be lost during the following read-in cycle.

In the more detailed block diagram shown in figure 3, this input selector switch is omitted. Figure 3 is the 'final' block diagram of the extended version of the TV scope. The shaded portions are the extension circuits, which will be described in greater detail next month; the remainder is the basic version of the TV scope, as described last month. Some of the sections are shown in dotted lines, and these are only required for the two-channel version of the TV scope – i.e. if two signals are to be displayed on the screen simultaneously. If a single-channel version is sufficient, these portions may be omitted.

The basic structure should be fairly clear by now. Y_A is the input amplifier for (one channel of) the TV scope; the circuit details were discussed last month. The output signal u_{ya} is fed direct to the inputs of two analogue shift registers (bucket brigade memories), A1 and A2. At any given moment, one of these shift registers operates as 'input memory' and the other as 'display memory'. The 'input memory' samples and stores the input signal, u_{ya} (as noted earlier, the same signal is also stored in the 'display memory', but it is lost during the next read-in cycle). The clock frequency for the read-in cycle – i.e. the sampling frequency – determines the ultimate 'timebase expansion'.

Figure 1. The basic principle of 'timebase expansion'. The original signal, 'a', is sampled ('b' and 'c'), slowed down ('d' and 'e') and retrieved ('f'). The result is a 'stretched' replica of the original input.

Figure 2. A simple block diagram of the extended version of the TV scope.

Figure 3. A more detailed block diagram. The portions shown shaded-in are the extension circuits, the remainder is the basic version of the TV scope as described last month. This diagram shows the complete two-channel version; the sections shown in dotted lines are not required for a single-channel TV scope.

This signal is generated by the 'input timebase' – the latter being basically equivalent to the timebase in a normal oscilloscope: the input clock frequency determines the time scale along the X-axis in the final display. The phrase 'input timebase' is used to distinguish this circuit from the existing timebase in the basic version of the TV scope (the circuit that provides the clock- and sync pulses required for the actual display).

As the input signal is being sampled and stored in the input memory, the information stored in the other memory during the previous cycle is displayed on the screen. To this end, the display memory receives its clock signal, u_{line}, from the (output) timebase. The frequency of this clock signal can be either equal to or half of the fixed sampling rate of the basic version of the TV – approximately 15 kHz or 7.5 kHz. The output from the display memory, selected by S_a, is fed to a low-pass filter in order to retrieve the original waveshape (see figure 1, e and f). This signal is then processed by the circuits already described in the basic version of the TV scope and displayed on the screen of the television receiver. When the display cycle is completed, the electronic switches S_a, S_c, S_d (and S_b) are operated; the input memory becomes display memory and vice versa.

Obviously, the circuits for the second channel (shown in dotted lines in figure 3) operate in exactly the same way.

Control signals

Even if the basic principle of the TV scope may by now seem fairly straightforward, getting it to work reliably in practice is another matter and some fairly intricate control circuitry is required. Two different clock signals are required for the memories: 256 pulses at the desired sampling frequency during the input cycle, followed by 256 pulses at TV line frequency (or half that) during the display cycle. Moreover, the two clock pulse trains (Ø1 and Ø2) must be fed to the memories at the correct point in the input and display cycles.

Since the memories are used alternately as input and display memory, and since the changeover occurs at the end of each cycle as determined by the u_{reset} pulses from the (output) timebase, the two clock signals must obviously be linked in some way to the u_{reset} pulses. This is illustrated in figure 4. As can be seen, a further signal u_m is generated, which changes state at every u_{reset} pulse. This signal determines which of the memories is to operate as input memory and which is to operate as display memory: it controls the electronic switches $S_a \ldots S_d$ in figure 3. The beginning of each display cycle is determined by the signal u_x. This signal goes 'high' shortly after each reset pulse, the delay between u_{reset} and u_x determining the position of the actual display along the time-axis ('X-position'). The beginning of the input clock pulse train is determined in a similar way by pulses generated by the trigger circuit, so that a stable picture can be obtained.

Each pulse train, both for Ø1 and for Ø2, consists of 256 pulses. The frequency of the output clock pulses is normally equal to TV line frequency; the input clock frequency is higher, and is determined by the desired time scale in the final display. The frequency of the u_{reset} pulses corresponds to TV frame frequency (50 Hz).

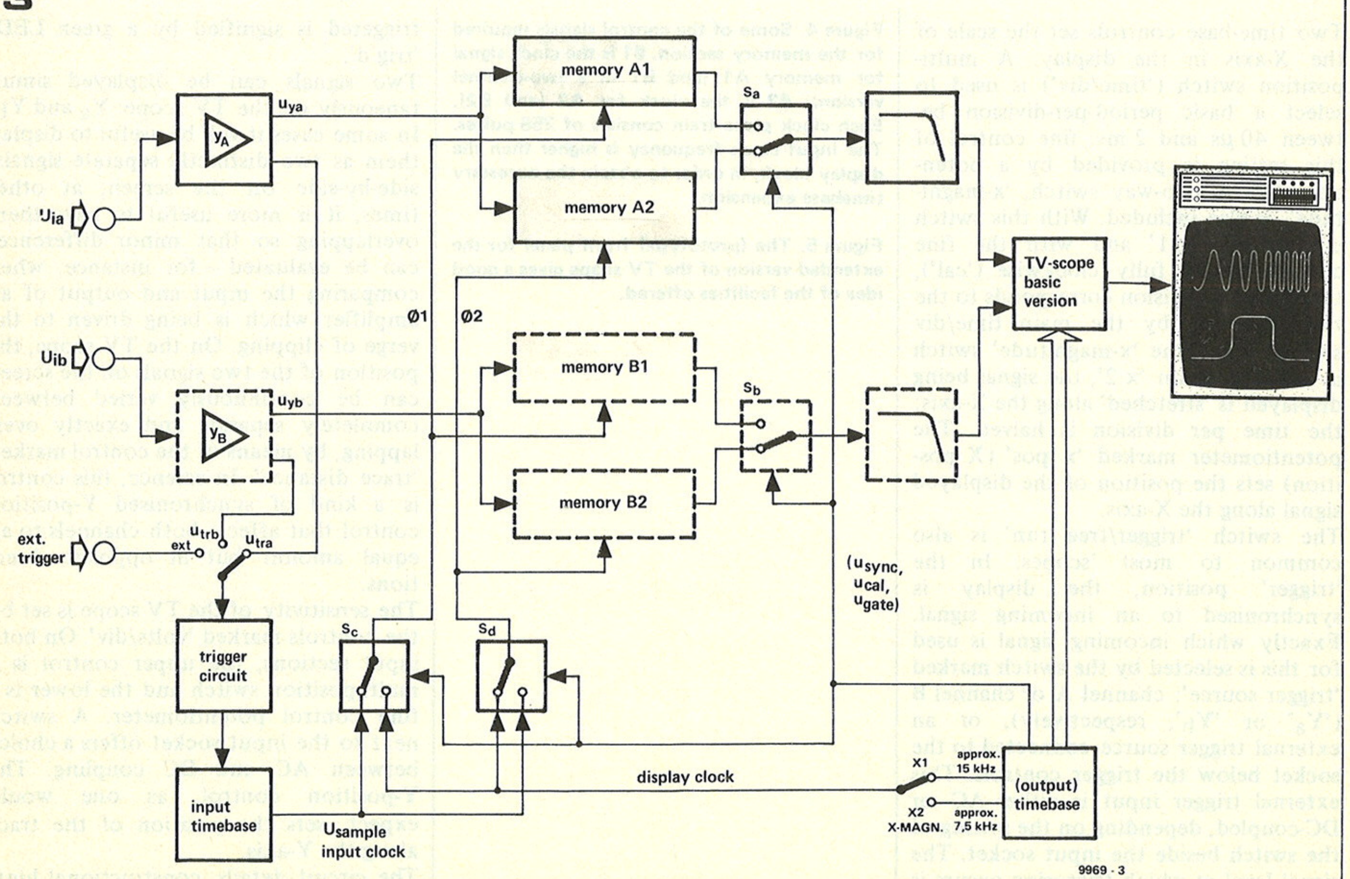
All the electronics involved in the memory circuits, including the control circuits that produce the signals shown in figure 4, are mounted on a single printed circuit board – the 'memory board'. This board can be linked into the basic version of the TV scope described last month, resulting in the 'extended version'.

Controls and facilities

The various facilities offered by the extended version of the TV scope can be assessed from the front panel controls. The prototype front panel is shown in figure 5. Most of the controls are direct equivalents of their counterparts on a 'normal' oscilloscope:

The on/off switch, labelled 'power', requires little explanation. Above it, there are two 'intensity' controls. 'Signal intensity' sets the brightness for the displayed signal; 'grid intensity' does the same for the calibration graticule.

3



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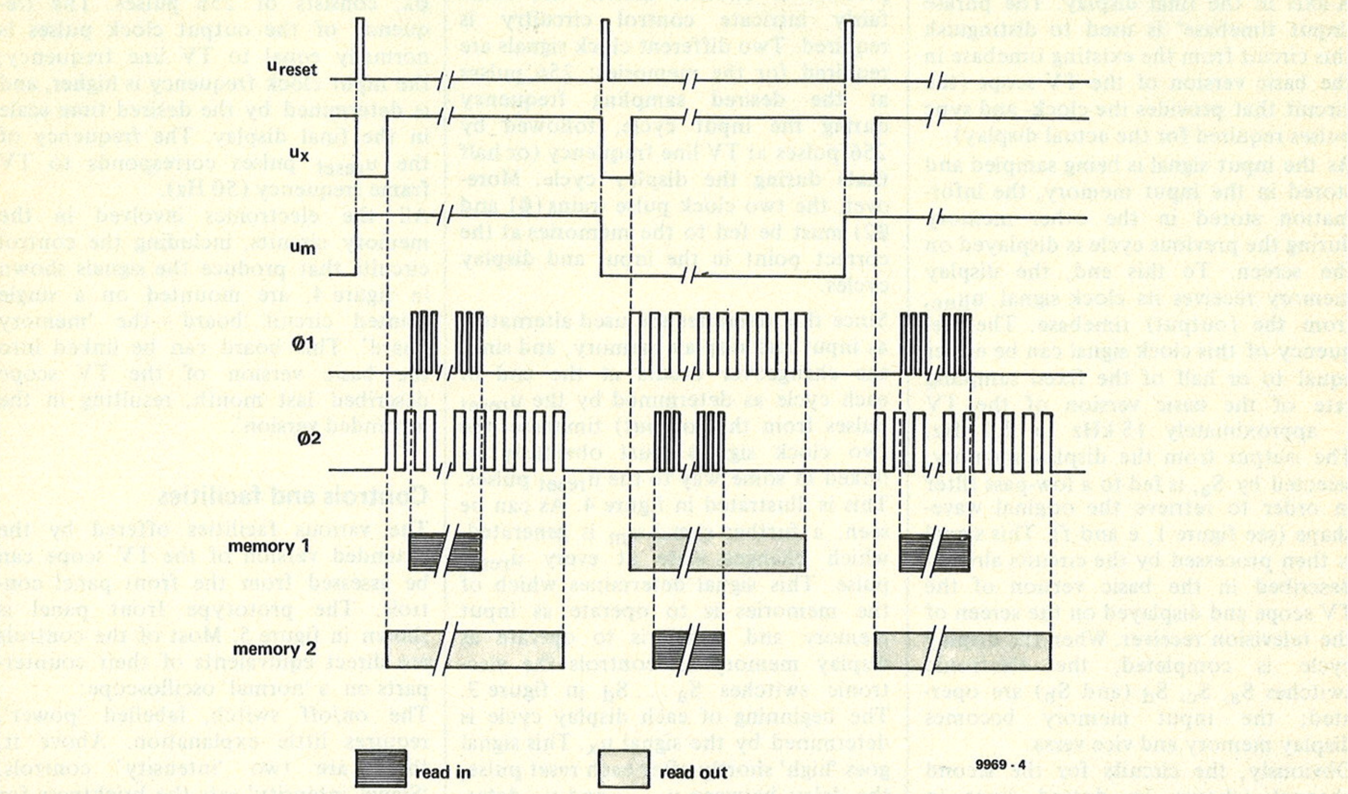


Figure 4. Some of the control signals required for the memory section. Ø1 is the clock signal for memory A1 (and B1 in a two-channel version); Ø2 is the clock for A2 (and B2). Each clock pulse train consists of 256 pulses. The input clock frequency is higher than the display clock, in order to obtain the necessary timebase expansion.

Figure 5. The (prototype) front panel for the extended version of the TV scope gives a good idea of the facilities offered.

Two time-base controls set the scale of the X-axis in the display. A multi-position switch ('time/div') is used to select a basic period-per-division between 40 μs and 2 ms; fine control of this setting is provided by a potentiometer. A two-way switch, 'x-magnitude', is also included. With this switch in position 'x 1' and with the fine control turned fully clockwise ('cal'), the time per division corresponds to the value selected by the main time/div switch. When the 'x-magnitude' switch is set in position 'x 2', the signal being displayed is 'stretched' along the X-axis: the time per division is halved. The potentiometer marked 'x pos' (X position) sets the position of the displayed signal along the X-axis.

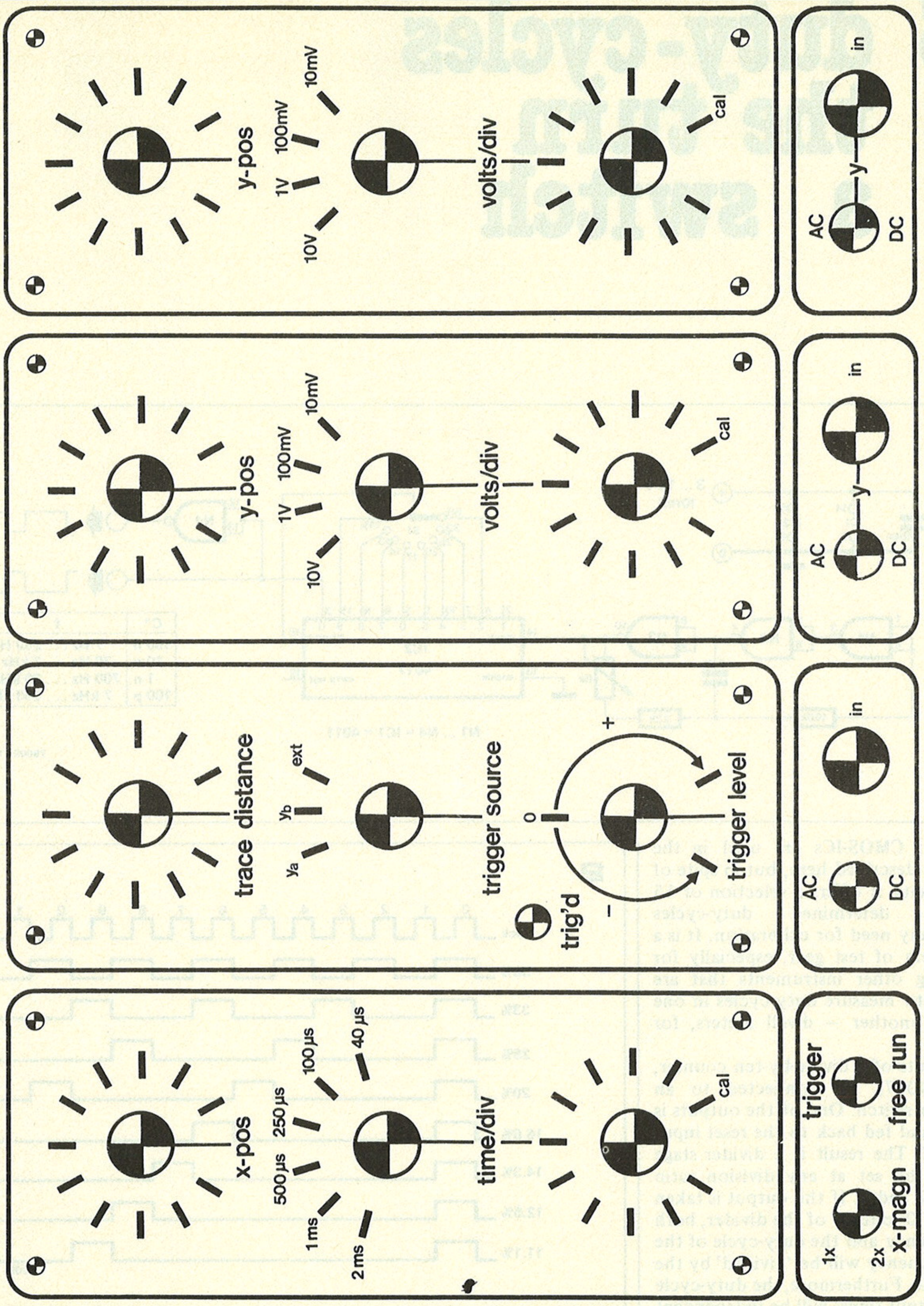
The switch 'trigger/free run' is also common to most 'scopes. In the 'trigger' position, the display is synchronised to an incoming signal. Exactly which incoming signal is used for this is selected by the switch marked 'trigger source': channel A or channel B ('Y_a' or 'Y_b', respectively), or an external trigger source connected to the socket below the trigger controls. This external trigger input is either AC- or DC-coupled, depending on the setting of the switch beside the input socket. The signal level at which triggering occurs is set by the 'trigger level' control; the fact that the TV scope is actually being triggered is signified by a green LED, 'trig'd'.

Two signals can be displayed simultaneously on the TV scope: Y_a and Y_b. In some cases it will be useful to display them as two distinctly separate signals, side-by-side on the screen; at other times, it is more useful to have them overlapping so that minor differences can be evaluated – for instance, when comparing the input and output of an amplifier which is being driven to the verge of clipping. On the TV scope, the position of the two signals on the screen can be continuously varied between completely separate and exactly overlapping, by means of the control marked 'trace distance'. In essence, this control is a kind of synchronised Y-position control that affects both channels to an equal amount but in opposite directions.

The sensitivity of the TV scope is set by the controls marked 'volts/div'. On both input sections, the upper control is a multi-position switch and the lower is a fine control potentiometer. A switch next to the input socket offers a choice between AC and DC coupling. The Y-position control, as one would expect, sets the position of the trace along the Y-axis.

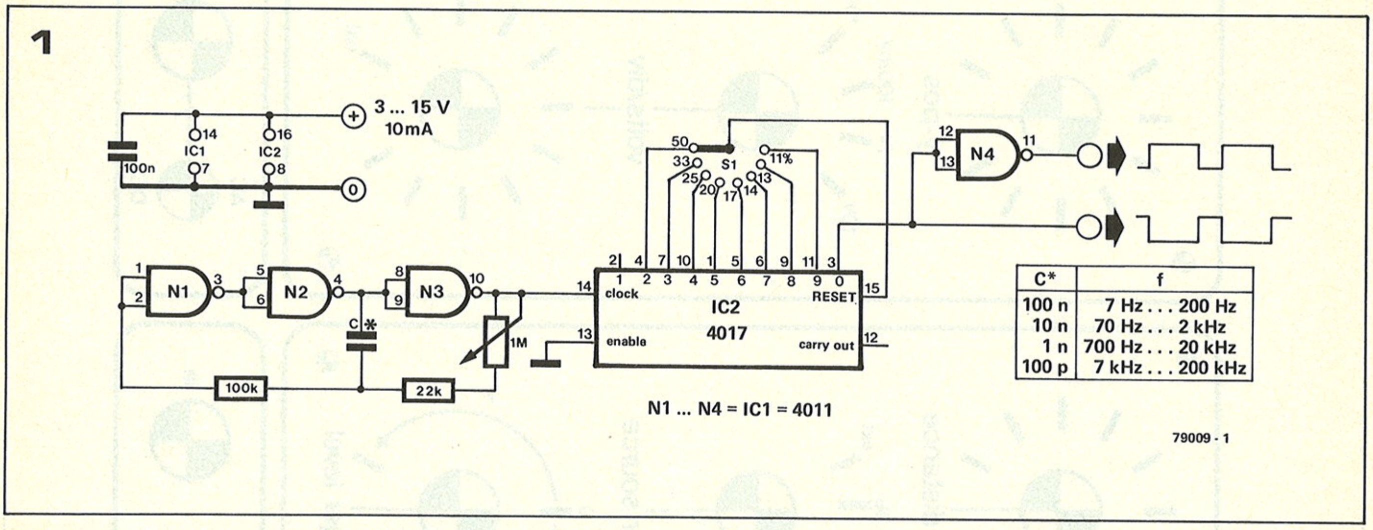
The circuit details, constructional hints and calibration procedure will be explained in detail next month. ◼

5


y-pos
10V
1V
100mV
10mV
volts/div
cal
AC
y
DC
in
y-pos
10V
1V
100mV
10mV
volts/div
cal
AC
y
DC
in
trace distance
ya
yb
ext
trigger source
trig'd
–
0
+
trigger level
AC
DC
in
x-pos
2ms
1ms
500μs
250μs
100μs
40μs
time/div
cal
1x
2x
x-magn
trigger
free run
elektor
signal intensity
grid intensity
on
power

15 duty-cycles at the turn of a switch

1



N1 ... N4 = IC1 = 4011

C*	f
100 n	7 Hz . . . 200 Hz
10 n	70 Hz . . . 2 kHz
1 n	700 Hz . . . 20 kHz
100 p	7 kHz . . . 200 kHz

Figure 1. Only two IC's are required for this little generator. The Table lists frequency ranges for a few capacitor values.

Only two CMOS-ICs are used in the generator described here, but in spite of its simplicity it offers a selection of 15 precisely determined duty-cycles without any need for calibration. It is a useful item of test gear, especially for calibrating other instruments that are designed to measure duty-cycles in one form or another – dwell meters, for instance.

The outputs of a divide-by-ten counter, the CD 4017, are connected to an 8-position switch. One of the outputs is selected and fed back to the reset input of the IC. The result is a divider stage that can be set at any division ratio between 2 and 9. If the output is taken from the '0' output of the divider, both the frequency and the duty-cycle of the input frequency will be 'divided' by the preset ratio. Furthermore, the duty-cycle of the output signal will be independent of the input frequency: it is determined only by the setting of the selector switch.

To complete the unit, a clock generator is included (N1 . . . N3). The 'clock' frequency is determined by the value of the capacitor, C, and by the setting of the 1 M potentiometer. The Table lists frequency ranges for a few capacitor values.

2

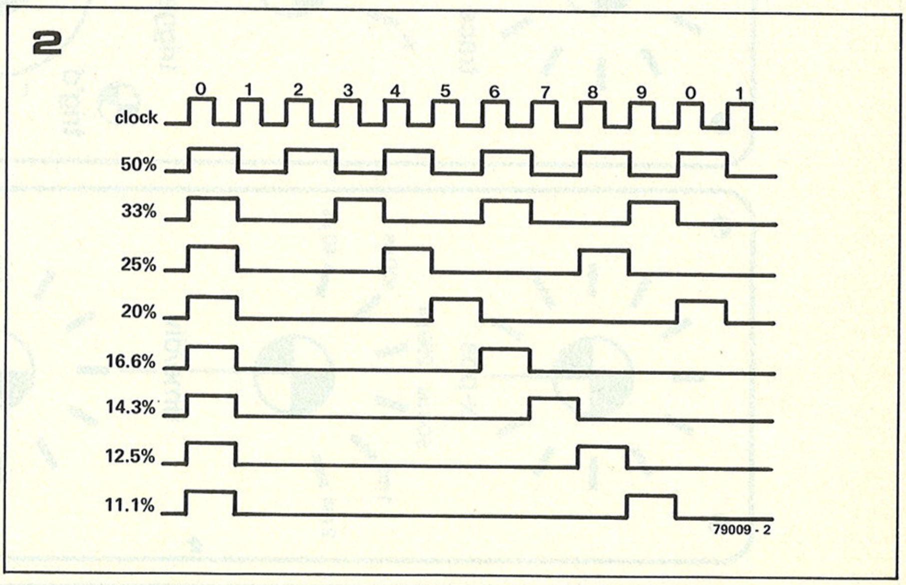


Figure 2. The duty-cycle at the output is determined by the division ratio.

The duty-cycle at the output (pin 3 of IC2) is equal to the division ratio times 100%. For instance, if output '5' (pin 1) of IC2 is selected, the division ratio is 1:5 and the duty-cycle is

$$\frac{100}{5} = 20\%.$$

No calibration required! As can be derived from figure 2, eight duty-cycles between 50% and 11.1% can be selected. N4 inverts the output signal, providing eight duty-cycles varying from 50% up to 88.9%. Since 50% is 50% no matter which way you look at it, the total number of duty-cycles available is fifteen.

The amplitude of the output signal is equal to the supply voltage, i.e. anywhere between 3 and 15 volts. ◼

hello, all you folks back home!

Modern technology has produced fast transport and centralised industry. A somewhat less desirable side-effect is that close relations have tended to become distant relations. Instead of gathering around the fire as in the 'good old days', we tend to gather around the telephone.

This means of communication suffers, however, from one major flaw: Ma Bell never intended it as a vital link between whole families. The system itself and all the legal restrictions involved with it are geared to private conversations between two individuals. The solution to the problem? A loudspeaking telephone.

1

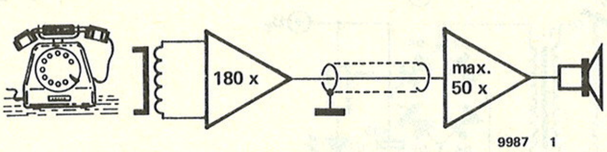


Figure 1. Block diagram of the telephone booster. The signal is picked up by a coil, since a direct connection into the telephone lines is not permitted. The booster itself consists of two sections, one mounted as close as possible to the phone and the other – much larger – section placed in any convenient spot.

The circuit described here will pick up the telephone conversation and reproduce it via a loudspeaker, so that several people can listen in.

This is only possible, of course, if the electrical signals from the telephone are first picked up in some way. Since the Post Office, understandably, does not like people tampering with their wiring, some kind of indirect coupling is required. The most common method is to use a so-called telephone pick-up coil. This operates on a very simple principle: in every telephone there is a transformer which is wound and wired in a cunning way in order to route the incoming signal from the telephone line to the earpiece, and at the same time feed the microphone signal onto the line. In effect, it forms a kind of splitter for audio signals, with good coupling from line to earpiece and from microphone to line, but with poor coupling between the microphone and earpiece to avoid acoustic feedback.

All transformers have a stray field, and this one is no exception. If a suitable coil is placed in this field, it will 'pick up' the audio signals. Logically enough, a device of this kind is called a pick-up coil. The electrical signal delivered by the coil is extremely small, so that a lot of gain is required in the following amplifier stages. As shown in the block diagram (figure 1), the amplifier described here consists of two sections. The first section has a gain of 180 (45 dB). It can be connected via almost any length of single-core screened cable to the second section, which has a gain of up to 50 (34 dB). This second stage drives the loudspeaker.

The advantage of cutting the circuit in two is that the first stage can be mounted quite near to the pick-up coil, minimising the amount of hum and interference picked up by the connecting wires. The bulk of the circuit, including loudspeaker and power supply, can be mounted at any suitable remote position.

Up to 50 m (160 ft) of screened cable can be used between the two stations – more than enough for any practical application we can imagine. The first section has no power supply of its own: it is powered from the main section via the connecting cable.

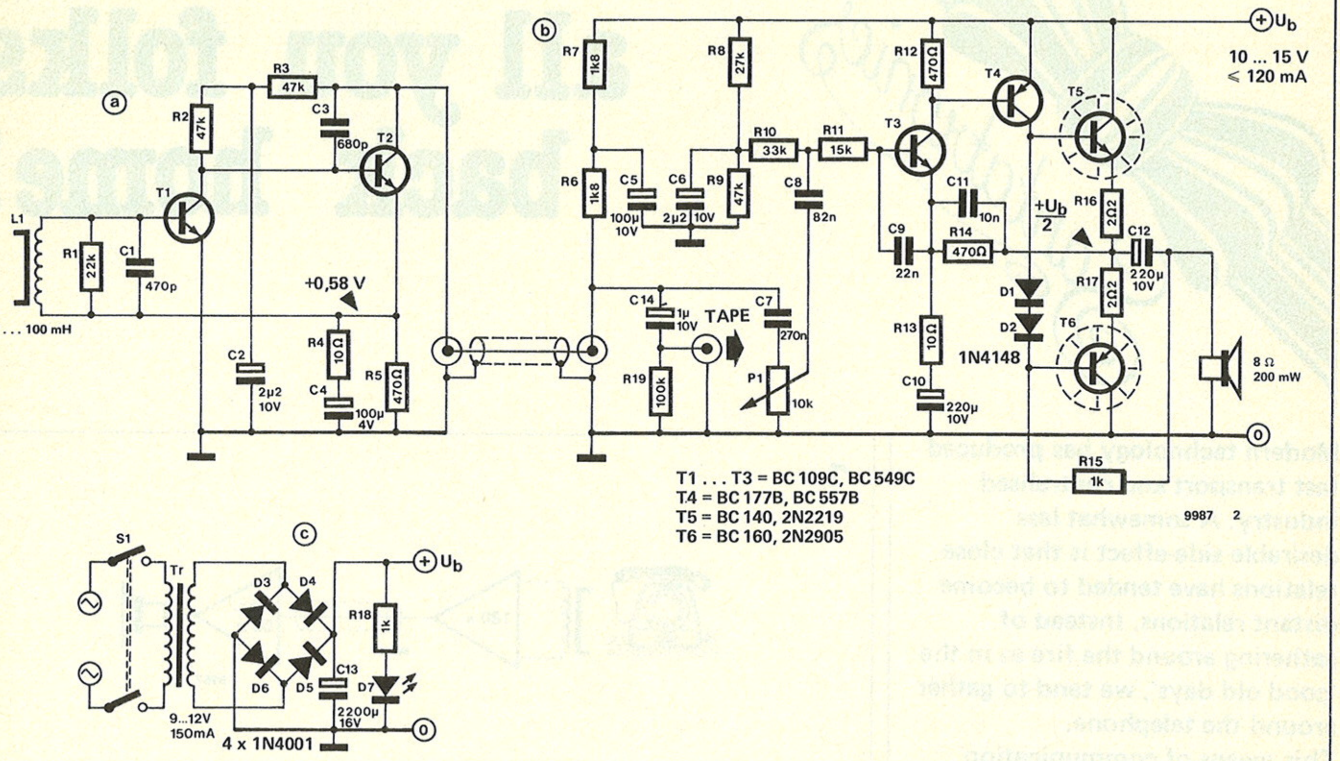
The circuit

The complete circuit is shown in figure 2: figure 2a is the first stage, which is mounted near the pick-up coil; figures 2b and 2c are the second stage and the power supply, respectively.

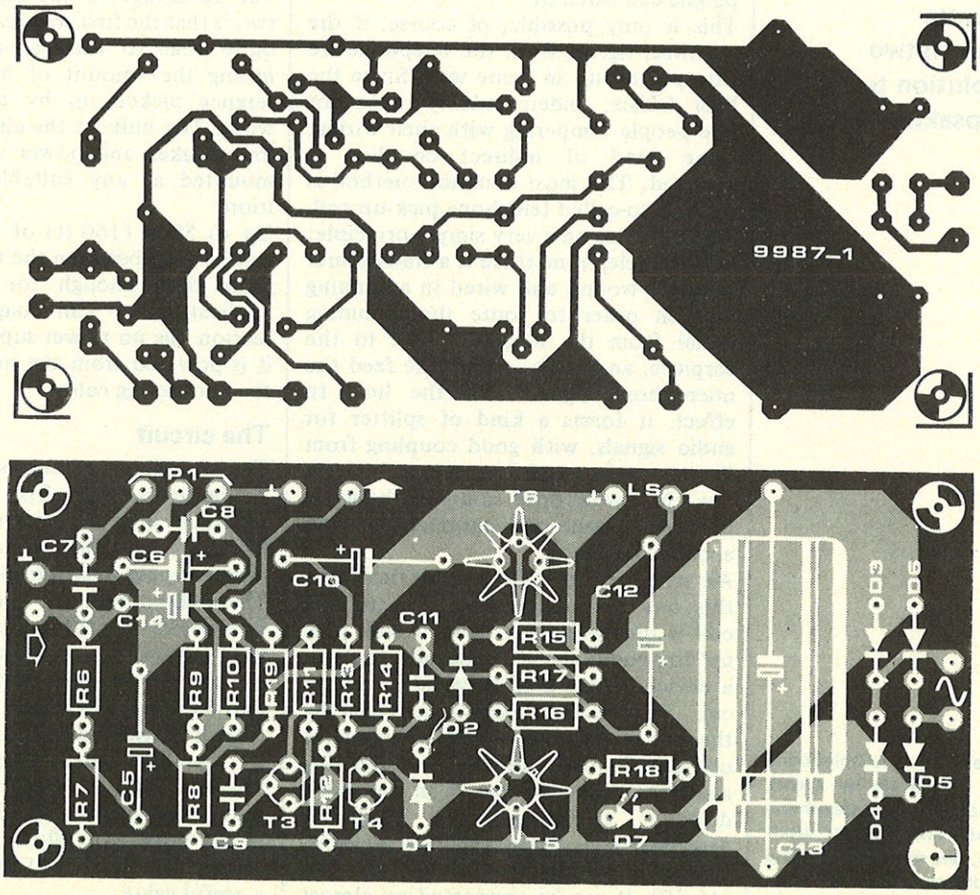
The pick-up coil, L1, is a normal miniature choke and the value is not particularly critical. It is sometimes possible to obtain coils designed specifically for this purpose, mounted in a plastic capsule with a suction cup at one end. L1 and C1 together form a resonant circuit, but this is so heavily damped by R1 and the input impedance of T1 that the resonant peak is hardly noticeable – the main effect is to limit the bandwidth to a useful value.

The first stage would be a two-transistor

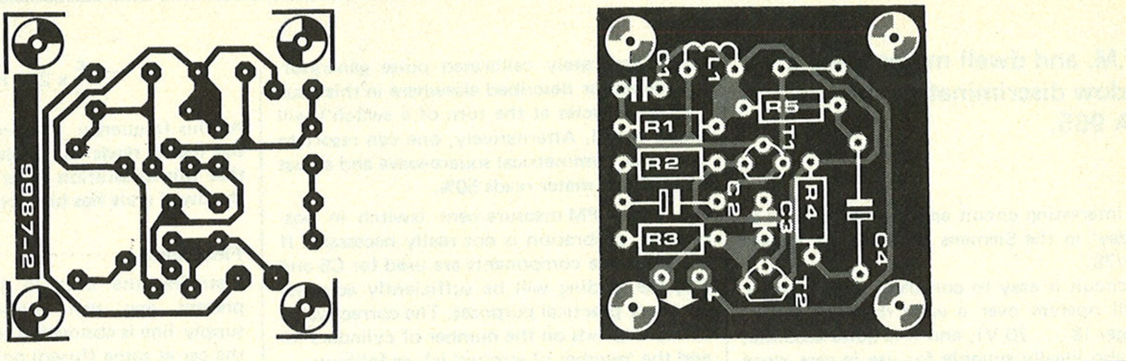
2


a
L1
47 ... 100 mH
R1 22k
C1 470p
T1
R2 47k
R3 47k
C3 680p
T2
C2 2μ2 10V
+0,58 V
R4 10Ω
C4 100μ 4V
R5 470Ω
b
R7 1k8
R6 1k8
C5 100μ 10V
C6 2μ2 10V
R8 27k
R9 47k
R10 33k
R11 15k
C8 82n
C14 1μ 10V
TAPE
C7 270n
R19 100k
P1 10k
R12 470Ω
T3
T4
T5
C11 10n
+Ub/2
C9 22n
R14 470Ω
R16 2Ω2
C12 220μ 10V
R17 2Ω2
D1
D2
1N4148
T6
R13 10Ω
C10 220μ 10V
+Ub
10 ... 15 V
≤ 120 mA
8 Ω 200 mW
0
R15 1k
T1 ... T3 = BC 109C, BC 549C
T4 = BC 177B, BC 557B
T5 = BC 140, 2N2219
T6 = BC 160, 2N2905
9987 2
c
S1
Tr
9...12V 150mA
D3
D4
D6
D5
4 x 1N4001
C13 2200μ 16V
R18 1k
D7
+Ub
0

3a


9987-1
P1
C8
C7
C6
C14
C10
T6
LS
C12
C11
R15
R17
R16
R6
R9
R10
R19
R11
R13
R14
D2
R7
C5
R8
C9
R12
T3
T4
D1
T5
R18
D7
D3
D6
D4
D5
C13

3b



Parts list

Resistors:
R1 = 22 k
R2,R3,R9 = 47 k
R4,R13 = 10 Ω
R5,R12,R14 = 470 Ω
R6,R7 = 1k8
R8 = 27 k
R10 = 33 k
R11 = 15 k
R15 = 1 kΩ
R16,R17 = 2Ω2
R18 = 1 k
R19 = 100 k
P1 = 10 k log.

Capacitors:
C1 = 470 p
C2,C6 = 2µ2/10 V
C3 = 680 p
C4 = 100 µ/4 V
C5 = 100 µ/10 V
C7 = 270 n
C8 = 82 n
C9 = 22 n
C10,C12 = 220 µ/10 V
C11 = 10 n
C13 = 2200 µ/16 V
C14 = 1 µ/10 V

Semiconductors:
T1,T2,T3 = BC 109C, BC 549C or equ.
T4 = BC 177B, BC 577B or equ.
T5 = BC 140, 2N2219
T6 = BC 160, 2N2905
D1,D2 = 1N4148
D3 . . . D6 = 1N4001
D7 = LED

Miscellaneous:
L1 = miniature choke, 47 . . . 100 mH, see text
LS = 8 Ω/200 mW loudspeaker
Tr = 9 . . . 12 V/150 mA mains transformer
S1 = DPDT mains switch

amplifier with a gain of 180, if T2 had a 1k8 collector resistor. Following the connecting cable, this resistor can indeed be located: R6 in figure 2b. This little trick, which was also used in the Preco, saves one wire: the same cable is used to feed the audio signal from the first section to the second and to supply power from the second section to the first. The output of the first section is basically a current source and can be loaded by a relatively low impedance, permitting the use of a fairly long cable.

The second section is a 'bare-bones' design: only four transistors and a handful of other components are used in this little power amplifier. There is no quiescent current adjustment – that would be an unneccessary luxury for this application. On the other hand, no quiescent current at all would be the other extreme – the maximum gain would be lower. P1 is the volume control. A tape output is also provided, although it should be noted that – strictly speaking – the other party should be notified if the conversation is to be recorded.

The power supply (figure 2c) is straightforward. The only 'luxury' there is the LED, D7.

Construction and use

Printed circuit board designs for the two sections are shown in figure 3. The main (figure 3b) contains both the second section and the power supply. It is perhaps interesting to note that this board can also be used on its own as a low-cost, low-fi 'power' amplifier, provided R6, R7 and C5 are omitted. For that matter, the complete unit can also be used as a 'low-fi' public address installation . . .

Note that T5 and T6 should be provided with cooling fins or clips. There's no harm in them running 'warm', but they're not supposed to get 'hot'.

The two sections can each be mounted in their own case (even a tobacco tin will do for the first stage!) and connected by means of the desired length of cable. The pick-up coil should be connected to the first stage by the shortest possible length of twin-core screened cable: the two ends of the coil are connected to the two cores and the screening is connected to supply common.

The best position for the pick-up coil can be found by trial and error. When the handset is lifted off the hook, a dialling tone is obtained (if no dialling tone is heard, complain to the Post Office, not us) and the pick-up coil can now be moved, twisted and turned all over the telephone (*not* the handset) until this tone is reproduced at maximum strength by the loudspeaker. Note that both the position of the coil and the direction in which it is pointing will influence the 'reception'. Once the best position and location have been found, the coil can be fixed in position.

Figure 2. The complete circuit. Figure 2a is the first section, which is connected by means of single-core screened cable to the second section, shown in figure 2b. The power supply, figure 2c, can also be mounted in the main station.

Figure 3. The two p.c. boards required. The larger of the two (figure 3a), EPS 9987 - 1, is for the main station including power supply; the second is for the first section of the circuit (EPS 9987 - 2).

APPLIKATOR

R.P.M. and dwell meter using a window discriminator, the TCA 965.

This interesting circuit appeared as 'Circuit of the day' in the Siemens Components Report no. 2/78.

The circuit is easy to construct and calibrate, it will operate over a wide range of supply voltages (8 . . . 20 V), and it is quite accurate. It is also ideally suitable for use in cars, since it is insensitive to temperature variations over a wide range and has high noise immunity.

Figure 1 shows the complete circuit, using a 1 mA instrument (a modification for more robust 10 mA instruments will be discussed later). With the switch in position 1 the circuit operates as a rev. counter. The input (CB) is connected to the contact breaker; R2, D3 and C2 provide protection against high voltage transients. When the contact breaker opens, the voltage at the input rises; as soon as the voltage at pin 6 exceeds the trigger voltage at pin 8 (i.e. 3 V, derived from the reference output, pin 5), the open-collector output at pin 13 is turned on for a period set by R3 and C5. During this set period, current therefore flows through the 1 mA instrument. This current is made virtually independent of supply voltage fluctuations by the simple expedient of deriving it from a second reference output, pin 10. The mechanical inertia of the meter is sufficient to integrate the current pulses, resulting in the desired RPM indication.

With the switch in position 2, the circuit operates as a dwell meter. Basically, it merely 'cleans up' the pulses from the contact breaker: as long as the latter is closed, current flows through the meter. As before, the inertia of the meter itself is sufficient to average-out the pulses – producing the desired reading.

The choice of component values shown is such that the same scale can be used for both measurements. In switch position 1, full scale corresponds to 8000 RPM. In position 2 (dwell), the meter will read full scale for an 80% duty-cycle (contact closed for 80% of the time).

It is common practice in automobile electronics to use heavily-damped and relatively insensitive instruments with a 270° scale. For instruments of this type, the circuit modifications shown in figure 2 are required. D5 and D6 compensate the relatively large temperature coefficient of the instrument, and D7 protects the IC from reverse-voltage spikes caused by the quite considerable inductance of the coil. Using this circuit, meters with a sensitivity of up to 10 mA f.s.d. can be employed.

Calibration

With the switch in position 2, apply a positive square-wave with an amplitude of 5 V and an 80% duty-cycle to the 'CB' input; adjust P1 until the meter reads full-scale (80%). If one does not have access to either an oscilloscope or an accurately calibrated pulse generator, the generator described elsewhere in this issue ('15 duty-cycles at the turn of a switch') will prove useful. Alternatively, one can resort to a normal, symmetrical square-wave and adjust P1 until the meter reads 50%.

For the RPM measurement (switch in position 1), calibration is not really necessary. If 5% tolerance components are used for C5 and R3, the reading will be sufficiently accurate for most practical purposes. The correct value of R3 depends on the number of cylinders (c) and the 'number of strokes' (s), as follows:

$$R_3 = \frac{s}{c} \times 40\ (k\Omega).$$

To give a few examples: for a four-cylinder four-stroke engine, R3 would be 40 k (use 39 k); for a 6 cylinder 4-stroke the correct value is 27 k.

Of course, if a pulse generator and a frequency counter are available, exact calibration is possible. R3 is replaced by a suitable preset potentiometer (50 k will be correct in most cases), and a square-wave of sufficient amplitude is applied to the CB input. The frequency is determined by the number of cylinders and 'strokes', as follows:

$$f = \frac{c}{s} \times 266\ \text{Hz}.$$

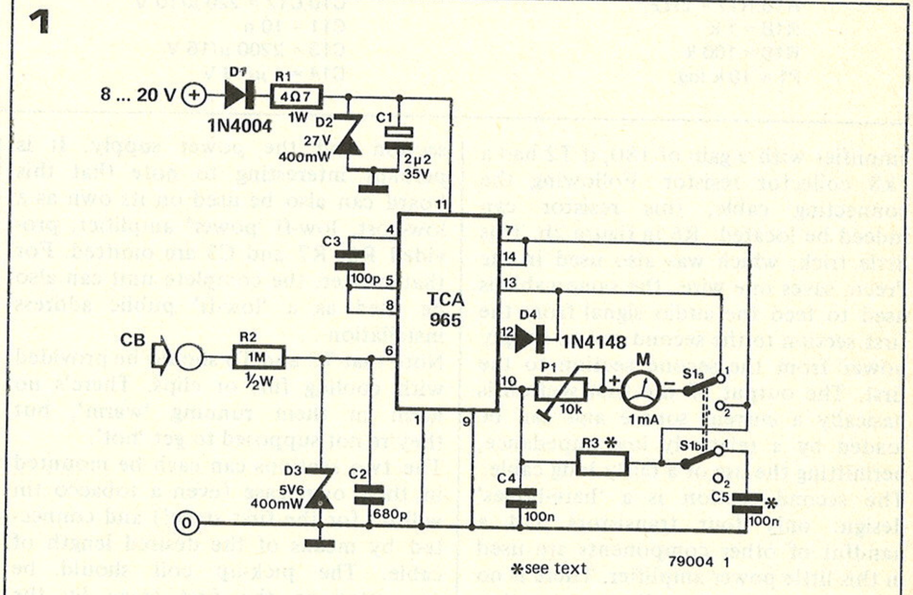
At this frequency, the preset is adjusted until the meter reads full scale (8000 RPM). Note that this calibration must be carried out after the dwell scale has been correctly calibrated!

Final notes

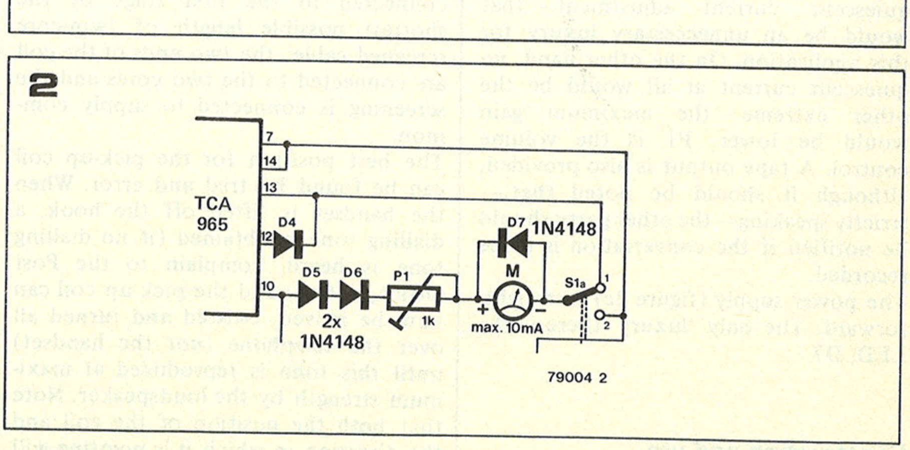
Installing the unit in the car should not present any real problems. The positive supply line is connected to the 12 V supply in the car at some (fused) point after the ignition switch – the connection for a car radio or cigarette lighter is usually a good point – and the 'supply common' connection is taken to the bodywork of the car at some convenient point near the meter (Note that the circuit is not intended for use in cars with positive ground!). Finally, the CB input is connected to the lead between the ignition coil and the contact breaker.

To avoid excessive interference problems, it is advisable to run the lead to the CB input as close to the metalwork of the car as possible for the whole of its length – keeping away from 'hot spots' of course! Better still, screened cable can be used, with the screen connected (at one end only!) to the bodywork of the car. ◆

1



2



Under the heading Applikator, recently introduced components and novel applications are described. The data and circuits given are based on information received from the manufacturer and/or distributors concerned. Normally, they will not have been checked, built or tested by Elektor.

SC/MP 'Mastermind' TM programme

Pit your wits against the computer with the aid of the following 'Mastermind' TM programme, which is designed to run on the Elektor SC/MP system.

F. Schuldt

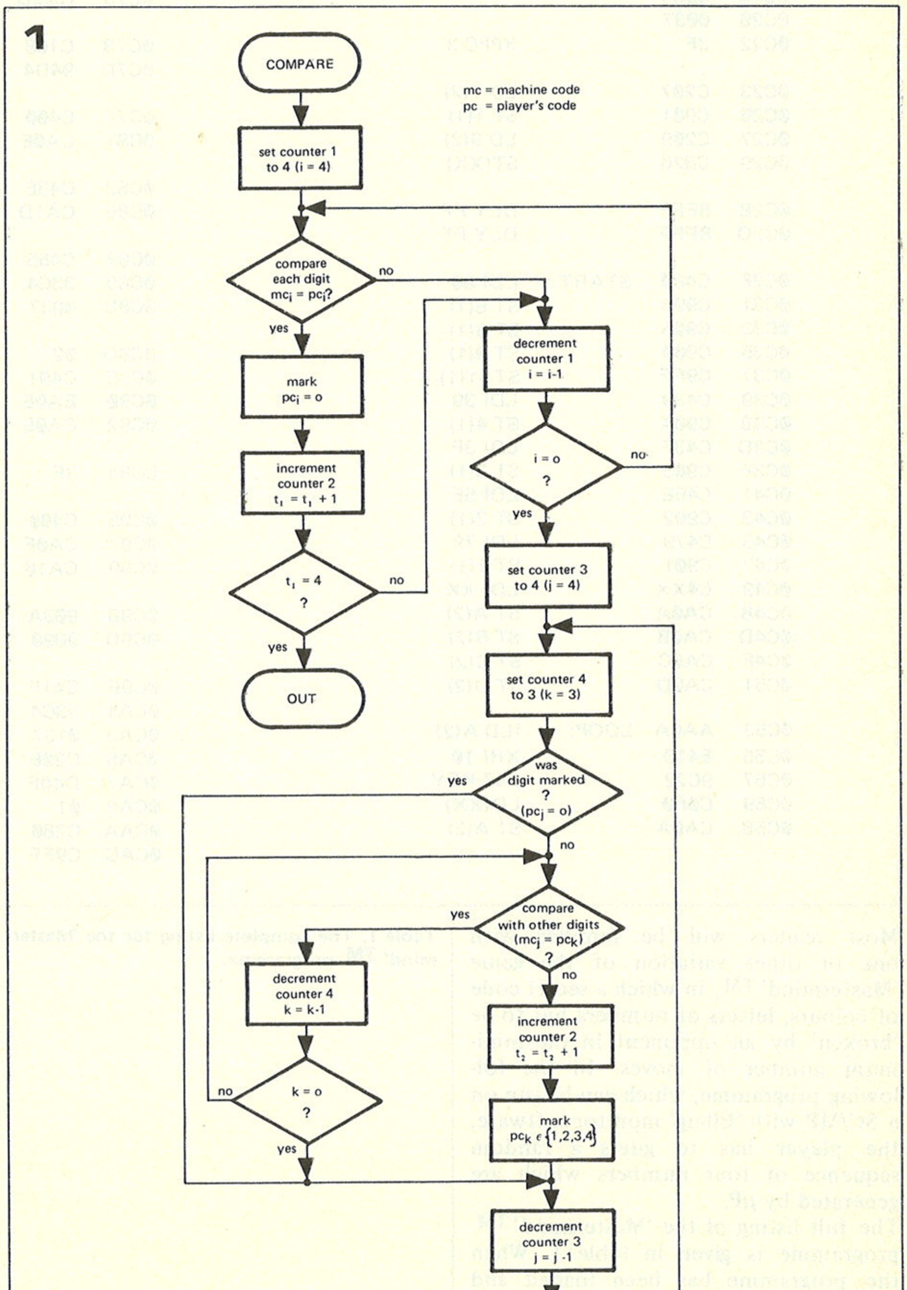

1
COMPARE
mc = machine code
pc = player's code
set counter 1 to 4 (i = 4)
compare each digit $mc_i = pc_i$?
no
yes
mark $pc_i = o$
increment counter 2 $t_1 = t_1 + 1$
$t_1 = 4$?
no
yes
OUT
decrement counter 1 i = i-1
i = o ?
no
yes
set counter 3 to 4 (j = 4)
set counter 4 to 3 (k = 3)
was digit marked ? ($pc_j = o$)
yes
no
compare with other digits ($mc_j = pc_k$) ?
yes
no
decrement counter 4 k = k-1
k = o ?
no
yes
increment counter 2 $t_2 = t_2 + 1$
mark $pc_k \in \{1,2,3,4\}$
decrement counter 3 j = j -1
j = o ?
no
yes
RESULT
9964 1

Figure 1. This flow-diagram should help to clarify the operation of the 'compare' routine.

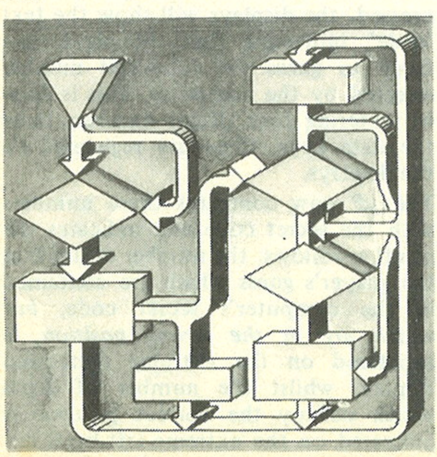


Table 1

```
0C00  C46D  ENTER:  LDI 6D
0C02  C906          ST 6(1)
0C04  C479          LDI 79
0C06  C905          ST 5(1)
0C08  C478          LDI 78
0C0A  C904          ST 4(1)
0C0C  C400          LDI 00
0C0E  C903          ST 3(1)
0C10  C902          ST 2(1)
0C12  C901          ST 1(1)
0C14  C440          LDI 40
0C16  C900          ST 0(1)
0C18  C471          LDI 71
0C1A  C9FF          ST-1(1)

0C1C  C455          XP3 (PUSH) - 1
0C1E  33C4
0C20  0037
0C22  3F            XPPC 3

0C23  C207          LD 7(2)
0C25  C901          ST 1(1)
0C27  C209          LD 9(2)
0C29  C820          ST(XX)

0C2B  8FFF          DLY FF
0C2D  8FFF          DLY FF

0C2F  C480  START:  LDI 80
0C31  C906          ST 6(1)
0C33  C905          ST 5(1)
0C35  C900          ST 0(1)
0C37  C9FF          ST-1(1)
0C39  C439          LDI 39
0C3B  C904          ST 4(1)
0C3D  C43F          LDI 3F
0C3F  C903          ST 3(1)
0C41  C45E          LDI 5E
0C43  C902          ST 2(1)
0C45  C479          LDI 79
0C47  C901          ST 1(1)
0C49  C4XX          LDI XX
0C4B  CA0A          ST A(2)
0C4D  CA0B          ST B(2)
0C4F  CA0C          ST C(2)
0C51  CA0D          ST D(2)

0C53  AA0A  LOOP:   ILD A(2)
0C55  E410          XRI 10
0C57  9C22          JNZ KEY
0C59  C0F0          LD(XX)
0C5B  CA0A          ST A(2)
```

```
0C5D  AA0B          ILD B(2)
0C5F  E410          XRI 10
0C61  9C18          JNZ KEY
0C63  C0E6          LD(XX)
0C65  CA0B          ST B(2)

0C67  AA0C          ILD C(2)
0C69  E410          XRI 10
0C6B  9C0E          JNZ KEY
0C6D  C0DC          LD(XX)
0C6F  CA0C          ST C(2)

0C71  AA0D          ILD D(2)
0C73  E410          XRI 10
0C75  9C04          JNZ KEY
0C77  C0D2          LD(XX)
0C79  CA0D          ST D(2)

0C7B  C108  KEY:    LD 8(1)
0C7D  94D4          JP LOOP

0C7F  C400          LDI 00
0C81  CA0E          ST E(2)

0C83  C43E  NEXT:   LDI L(GETHEX)-1
0C85  CA1D          ST 1D(2)

0C87  C455          XP3(PUSH)-1
0C89  33C4
0C8B  0037

0C8D  02            CCL
0C8E  C401          LDI 01
0C90  EA0E          DAD E(2)
0C92  CA0E          ST E(2)

0C94  3F            XPPC 3

0C95  C400          LDI 00
0C97  CA0F          ST F(2)
0C99  CA10          ST 10(2)

0C9B  903A          JMP COMP
0C9D  9090  JS:     JMP START

0C9F  C41F  OUT:    XP3(TAB)-1
0CA1  33C4
0CA3  0137
0CA5  C20E          LD E(2)
0CA7  D40F          ANI 0F
0CA9  01            XAE
0CAA  C380          LD-128(3)
0CAC  C9FF          ST-1(1)
```

Table 1. The complete listing for the 'Mastermind' ^{TM} programme.

Most readers will be familiar with one or other variation of the game 'Mastermind' ^{TM}, in which a secret code of colours, letters or numbers has to be 'broken' by an opponent in the minimum number of moves. In the following programme, which can be run on a SC/MP with 'Elbug' monitor software, the player has to guess a random sequence of four numbers which are generated by μP.

The full listing of the 'Mastermind' ^{TM} programme is given in table 1. When the programme has been loaded and started (by hitting the RUN-key), the text 'set –F' should appear on the displays. The player can then select the desired difficulty level by pressing one of the keys from 4 to F. This determines which hexadecimal digits the μP can use to make up the code which the player has to break. If, for example, the key '9' is pressed, then the code 'word' may consist of a combination of any four digits between 9 and F (i.e. 9, A, B, C, D, E, or F).

Once the desired data key has been pressed, the displays will show the text 'code', indicating that the player can begin to guess the four-digit number selected by the computer. This is done by entering four (legal) numbers from the data keys, these are registered on the displays.

The μP now compares these numbers with the secret code and indicates the result as follows: the number of digits in the player's guess which are contained in the computer's secret code, *but which are in the wrong position*, is registered on the extreme right-hand display, whilst the number of digits which occupy the correct position is indicated on the extreme left-hand dis-

Table 1, cont.

```
0CAE  C20E            LD E(2)
0CB0  1C1C            SR
0CB2  1C1C            SR
0CB4  01              XAE
0CB5  C380            LD-128(3)
0CB7  C900            ST 0(1)

0CB9  C479            LDI 79
0CBB  C906            ST 6(1)
0CBD  C437            LDI 37
0CBF  C905            ST 5(1)
0CC1  C45E            LDI 5E
0CC3  C904            ST 4(1)
0CC5  C400            LDI 00
0CC7  C901            ST 1(1)
0CC9  C902            ST 2(1)
0CCB  C903            ST 3(1)

0CCD  C108   WAIT:    LD 8(1)
0CCF  94FC            JP WAIT
0CD1  8FFF            DLY FF
0CD3  90C8            JMP JS

0CD5  90AC   JN:      JMP NEXT

0CD7  C4E7   COMP:    XP3(STKBSE)+7
0CD9  33C4
0CDB  0F37

0CDD  C404            LDI 04
0CDF  CA00            ST 0(2)

0CE1  C7FF   §1:      LD @-1(3)
0CE3  E307            XOR 7(3)
0CE5  9C08            JNZ §2

0CE7  CB00            ST 0(3)
0CE9  AA0F            ILD F(2)
0CEB  E404            XRI 04
0CED  98B0            JZ OUT

0CEF  BA00   §2:      DLD 0(2)
0CF1  9CEE            JNZ §1

0CF3  C701            LD @+1(3)
0CF5  C4EA            XP1(STKBSE)+A
0CF7  31C4
0CF9  0F35

0CFB  C404            LDI 04
0CFD  CA00            ST 0(2)
0CFF  C403   §3:      LDI 03
0D01  CA01            ST 1(2)
```

```
0D03  C501            LD @+1(1)
0D05  01              XAE

0D06  C1F8            LD-8(1)
0D08  9809            JZ §5

0D0A  40     §4:      LDE
0D0B  E701            XOR @+1(3)
0D0D  9C16            JNZ §6

0D0F  AA10            ILD 10(2)
0D11  CBFF            ST-1(3)

0D13  BA00   §5:      DLD 0(2)
0D15  9814            JZ RESLT

0D17  C1F8            LD-8(1)
0D19  C9FC            ST-4(1)

0D1B  31              XPAL 1
0D1C  0140            STE
0D1E  33              XPAL 3
0D1F  40              LDE
0D20  31              XPAL 1
0D21  C7FA            LD @-6(3)

0D23  90DA            JMP §3
0D25  BA01   §6:      DLD 1(2)
0D27  98EA            JZ §5
0D29  90DF            JMP §4

0D2B  C401   RESLT:   XP1 (DISPL)+1
0D2D  31C4
0D2F  0735

0D31  C41F            XP3(TAB)-1
0D33  33C4
0D35  0137

0D37  C20F            LD F(2)
0D39  01              XAE
0D3A  C380            LD-128(3)
0D3C  C906            ST 6(1)

0D3E  C210            LD 10(2)
0D40  01              XAE
0D41  C380            LD-128(3)
0D43  C9FF            ST-1(1)

0D45  908E            JMP JN
```

play. On the basis of this information, the player then enters a second number, whereupon the μP will respond in a similar fashion, indicating how many digits are correct and how many are in the right place etc. This continues until the player finally guesses the secret code, at which point the text 'End XX' will appear on the displays, the number XX indicating how many attempts the player took to guess correctly. The game can be restarted by pressing one of the data keys. If the difficulty level is to be modified, the game must be restarted with the 'Run' key.

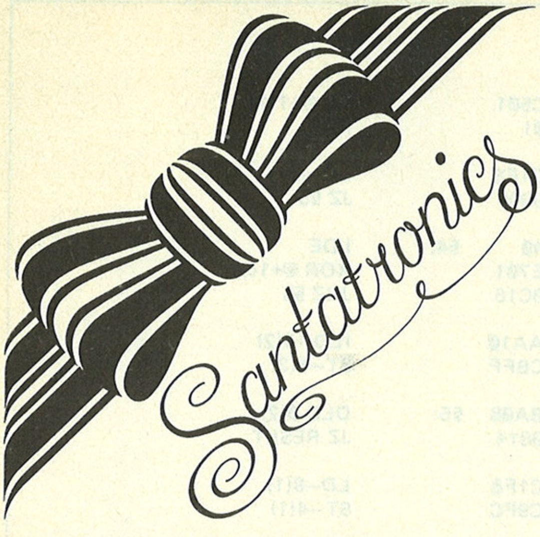
Compare routine

As already mentioned, the 'Mastermind' ^{TM} programme can only be run on a system with 'Elbug' monitor software. This is because the programme utilises several Elbug sub-routines so as to save memory space.

A complete explanation of the programme would be too lengthy, however it is worthwhile taking at look at the most interesting section, namely the compare routine, the flow diagram of which is shown in figure 1. The first part of this routine compares each digit of the computer code with the corresponding digit of the player's guess. If one or more of the comparisons are positive, then that digit is noted as being both correct and in the right position (if all four comparisons prove positive, then the player's guess is obviously correct, and the programme exits from the routine). The digits which were not marked as correct are next compared, one at a time, with the remaining digits of the computer's code. If any of these comparisons proves positive, the corresponding digit is noted as being correct, but not in the proper position. When all the comparisons are complete, the final result is displayed via the Elbug routines.

Along with those programmes previously published ('reaction timer' and 'digital clock'), and a number of programmes which are still to appear, 'Mastermind' ^{TM} will also be available on the disc to be produced by the Elektor Software Service (see the article on this subject in Elektor 38, June 1978).

TM We acknowledge the fact that 'Mastermind' is a registered trade mark of Invicta Plastics Ltd., Oadby, Leicester.



pocket bagatelle

An electronic version of the age-old dexterity game.

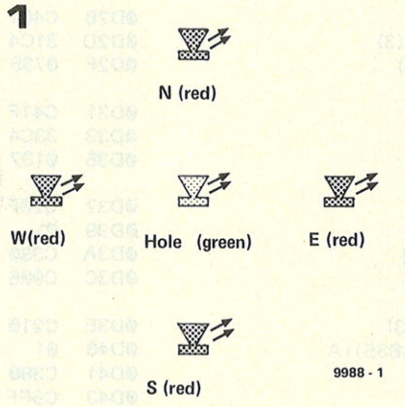
Many traditional games, which have been passed on unchanged from generation to generation, can now be simulated electronically (see, e.g. 'Marbles' in Elektor 21, January 77). In particular, 'video' games, which utilise the screen of a TV set to represent the field of play, have achieved enormous popularity in recent years, and with the advent of more and more complex 'games chips', this trend shows little sign of slowing down. However there are still many electronic versions of popular games which can be played without recourse to a TV set. One of the more simple (but not necessarily easy!) games, which is ideally suited as a small Christmas present, is 'bagatelle'.

There are several variations of the game 'bagatelle'; the one described here belongs to the species of manual dexterity games which are designed to test a steady hand, strong nerves and infinite patience. The original and simplest version of the game consists of a round flat container with a transparent top, inside which a small ball rolls around. The object of the game is to manoeuvre the ball into a shallow hole set into the bottom of the container. However, since the ball is very small and light, and both it and the surface over which it rolls are extremely smooth and have a very low coefficient of friction, it is extraordinarily difficult to control the direction in which the ball will move, or indeed to hold it steady at any one point. Furthermore, the hole itself is quite shallow, and very little is needed to make the ball jump back out.

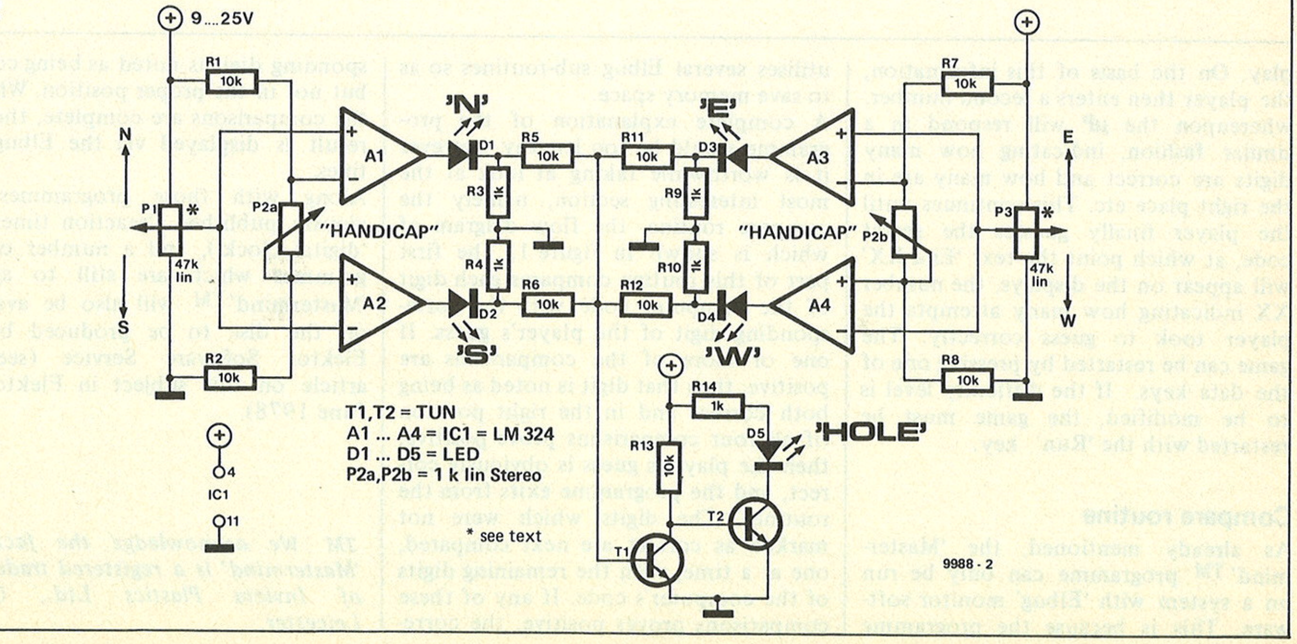
This fact is particularly annoying if one has a more complicated version of the game with two or more balls to be manoeuvred into two or more holes. It is quite amazing how many times one can manipulate one ball into its hole and be just on the point of succeeding with the second, when the first ball suddenly pops back out. Grown men have been seen to weep with frustration!

With Christmas not too far away, the following circuit for an electronic version of this tantalising game may help to solve that perennial problem of choosing presents – especially as far as younger relatives are concerned.

1



2



The game is played as follows: a single 'ball', whose position is indicated by four LEDs, has to be manoeuvred into a central 'hole' represented by a LED of a different colour. The arrangement of the LEDs is shown in figure 1. The 'ball', which in fact does not physically exist, can be 'rolled' in two directions: north-south and east-west. The four LEDs, one at each of the compass points, indicate whether the ball is to the north, south, east or west of the 'hole'. The position of the ball is controlled by two potentiometers, one for each direction. When the ball has been successfully manoeuvred into the 'hole', the central LED lights up and the other four LEDs are all extinguished. The degree of difficulty of the game, as it were the 'size of the hole', can be varied by means of a third, 'handicap' potentiometer.

The circuit

The electronics of the game are revealed in the circuit diagram of figure 2. The circuit basically consists of the two window comparators formed by A1/A2 and A3/A4. To help explain how this type of circuit works, the basic circuit diagram of a window comparator is shown in figure 3. As can be seen, the circuit has a single input signal, u_i, and two output signals, u_1 and u_2. Op-amps A1 and A2 are connected as comparators, i.e. due to the absence of feedback, their outputs are always in one of two states: either high or low. When the voltage at the non-inverting (+) input of a comparator is greater than that at the inverting (−) input, the output voltage of the device swings up to + supply. However if the voltage on the inverting input is greater than that at the non-inverting input, then the output of the comparator swings down to − supply, in this case, to ground.

One of the inputs of each comparator shown in figure 3 is connected to a constant reference voltage. These reference voltages, U_a and U_b, are derived from an attenuator network, consisting of R1, R2 and P. Depending upon the value of the input voltage, u_i, one of three possible situations can occur:

a. U_i is greater than U_a, in which case u_1 will be high and u_2 low.
b. u_i is smaller than U_b, in which case u_2 will be high and u_1 low.
c. u_i lies between U_a and U_b, in which case both u_1 and u_2 will be low.

When this occurs, the input voltage, u_i, can be said to lie 'inside the window'. The height of the window can be varied by means of potentiometer P.

These three situations are illustrated by the diagram of figure 4, which shows how the outputs of the two op-amps react to a rising input voltage.

Two such window comparators are employed in the circuit of the pocket bagatelle. The input of each is derived via a potentiometer, these being P1 and P3 respectively. P1 controls the vertical position of the ball, whilst P3 varies the horizontal position. Each of the outputs of the two window comparators drives an LED; it is clear from figure 4 that each output voltage goes high when the input voltage of the window comparator lies on that 'side' of the window. With two window comparators, whose input voltages represent the horizontal *and* vertical position of the 'ball' (and whose windows intersect) it is obvious that the logic state of the comparator outputs, and hence the on/off state of the corresponding LEDs, tell us whether or not the 'ball' has 'rolled' to a given side of the 'hole'. If all four 'pointer' LEDs are extinguished, the centre LED will come on indicating that the player has succeeded and the ball has been manoeuvred into the hole.

The LEDs are driven directly by the outputs of the comparators; the current through the LEDs is limited by a series resistor. The voltage across this resistor is also used to turn on T1. This transistor will remain conducting as long as one of the LEDs D1 . . . D4 is lit. If all four LEDs are extinguished, however, T1 will turn off, causing T2 to turn on, and the green central LED, D5, to light up.

The dimensions of the window, and hence the difficulty level of the game, can be varied by means of stereo potentiometer P2ab.

Figure 1. The board of the 'pocket bagatelle' contains five LEDs. The middle (green) LED lights up when the player succeeds in rolling the ball into the hole. The other four (red) LEDs indicate the position of the ball relative to the hole.

Figure 2. The complete circuit diagram of the pocket bagatelle, which is based on two window comparators.

3

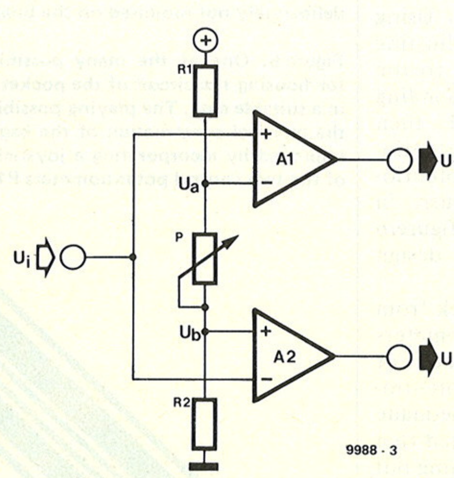


Figure 3. The basic circuit of a window comparator.

4

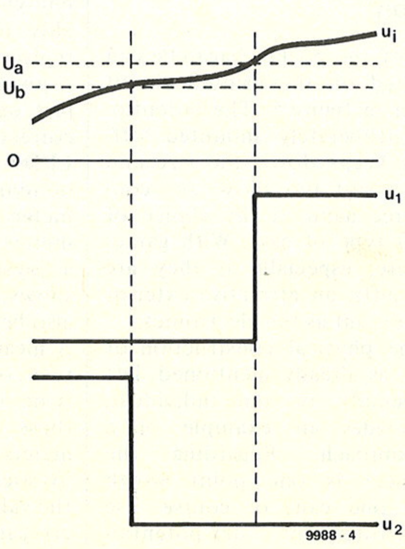
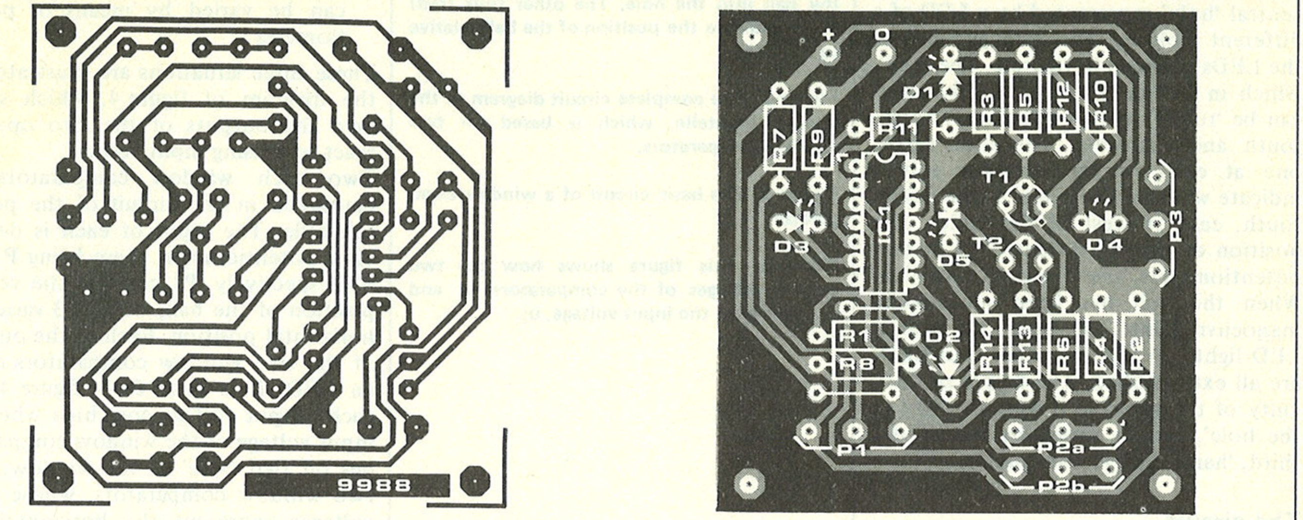


Figure 4. This figure shows how the two output voltages of the comparators, u_1 and u_2, vary with the input voltage, u_i.

5



Parts list

Resistors:
R1,R2,R5 . . . R8,
R11, R12,R13 = 10 k
R3,R4,R9,R10,R14 = 1 k
P1,P3 = 47 k (50 k) lin
potentiometer
P2ab = 1 k lin
stereo potentiometer

Semiconductors:
IC1 = LM324
T1,T2 = TUN
D1 . . . D4 = LED red
D5 = LED green

6

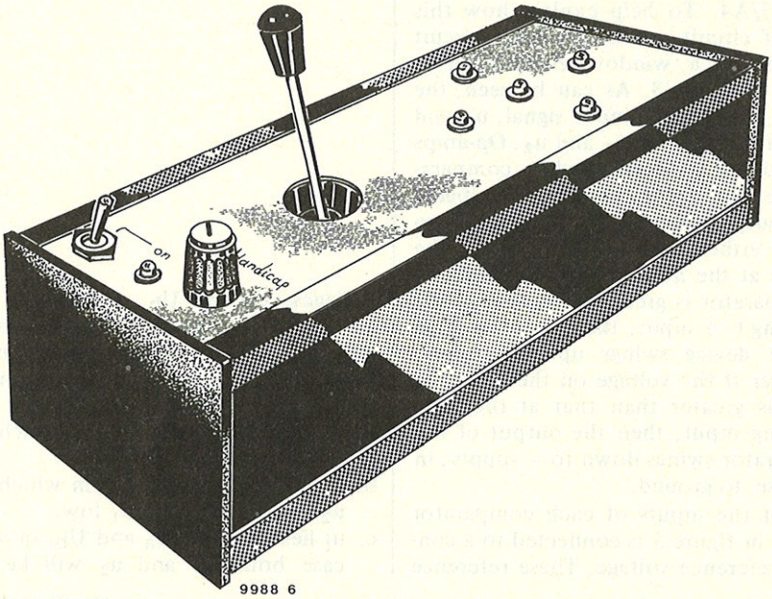


Figure 5. The printed circuit board for the pocket bagatelle. The potentiometers are deliberately not mounted on the board.

Figure 6. One of the many possible designs for housing the circuit of the pocket bagatelle in a suitable case. The playing possibilities and the physical construction of the bagatelle are improved by incorporating a joystick in place of the two control potentiometers P1 and P3.

Construction

The circuit of the pocket bagatelle can be constructed on the printed circuit board shown in figure 5. The potentiometers are deliberately mounted 'off-board'. This keeps down the size and cost of the board and allows the constructor a free hand in the choice of controls and type of case. With games such as these, especially if they are intended as gifts, an attractive exterior is just as important as the electronics.

Although the physical construction of the game is, as already mentioned, left to the ingenuity of the individual, figure 6 provides an example of a possible approach. Regarding the controls, there is one point worth mentioning: one can, of course, use conventional rotary- or slider potentiometers for P1 and P3. However, if one is willing to go to the extra expense (or trouble of making it oneself), the enjoyment of the game can be considerably enhanced by using a joystick to replace these two potentiometers. Using a joystick prevents one from adjusting just one of the potentiometers to the correct position (until the corresponding LEDs are extinguished), and then homing in with the second potentiometer. Like it or not, both potentiometers are operated simultaneously in a joystick. What is more, as figure 6 shows, a more interesting case design also becomes possible.

A means of constructing a joystick from two conventional rotary potentiometers is discussed elsewhere in this issue. For those readers who do use potentiometers (whether in a home-made joystick or not), it should be noted that the values of P1 and P3 are anything but critical and if needed, could lie anywhere between 1 k and 1 M. It is also of little importance if P1 and P3 have different, even widely different values. ◆

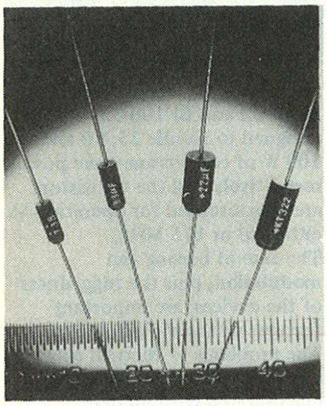
MARKET

Subminiature Tantalum capacitors

A new series of Kemet subminiature axial-leaded tantalum capacitors in a high precision epoxy moulding has been launched by Union Carbide UK Limited Electronics Division.

Designated the T 322 series, it is designed for high speed automatic insertion applications as the four case sizes correspond to standard resistor and diode sizes.

These capacitors offer an extremely high volumetric efficency and include among their applications decoupling, blocking, bypassing and filtering in computers, data processing, communications and other electronic equipment.



Electrical ratings extend from 68 μF/6 V through 4.7 μF/50 V.

The temperature range spans −55°C to +85°C (or to +125°C with voltage derating).

The T 322 series replaces the T 320 series of epoxy moulded tantalums and metal-cased types.

Prices for the new series are significantly lower than for the larger T 320 series, and compare favourably with the standard T 310 axial-moulded type.

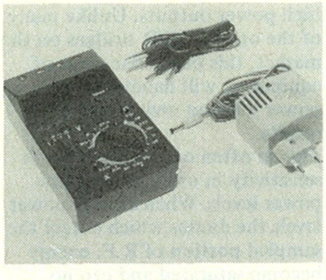
Union Carbide UK Limited,
Electronics Division,
Hilton Road,
Aycliffe Industrial Estate,
Nr. Darlington,
Co Durham DL5 DL6

(919 M)

4 Digit multimeter

Known as the Digimer 10, this new portable instrument from Iskra Limited also enables a.c. measurements to be taken at frequencies from 20 Hz up to 50 kHz. The digits are readable over a horizontal angle of 150°, and a vertical angle of 90°.

Other outstanding features of the Digimer 10 include: 17 ranges, an accuracy of ± 0.05%, ± 1 digit; automatic polarity indication; a selection of optional shunts for measuring higher currents; and rechargeable nickel-cadmium batteries that power the multimeter for eight hours between charging operations. In addition, the Digimer 10 can be used while connected to an optional battery charger, except when measuring parameters involving voltages above 1000 volts.



Carefully designed to maximise ease of use, the Digimer 10 has a 7-segment LED display. The figures are 7.62 mm high, and the display is angled for optimum readability when used on a flat surface. Only two controls provide instant range switching to any one of the 17 ranges.

A built-in over-ranging trip circuit allows safe operation on all ranges up to 50% above full-scale deflection value. The unit features integral automatic drift compensation and overload protection.

Voltage ranges (a.c. and d.c.) have a high degree of resolution, which is given in brackets after each full-scale deflection: 200 mV (0.1 mV), 2 V (1 mV), 20 V (10 mV), 200 V (100 mV), and 2000 V (1 V).

Current ranges (a.c. and d.c.) and their resolutions are: 20 μA (10 nA), 200 μA (100 nA), 2 mA (1 μA), 20 mA (10 μA), 200 mA (100 μA), and 2 A (1 mA).

Resistance readings extend from 0.1 ohm to 20 megohms in six ranges. Under over-ranging conditions, each range is increased by 50%.

All d.c. and resistance measurements have a sampling time of approximately 300 milliseconds. And the unit is designed to operate at any temperature from 0 to 55°C.

Iskra Limited,
Redlands, Coulsdon,
Surrey CR3 2HT.

(929 M)

Compact bridges

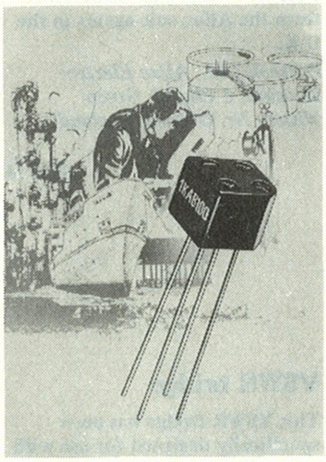
Designed for the user who demands an economical product without sacrificing quality, reliability and electrical performance. International Rectifier announce the introduction of a range of small single phase bridge rectifiers.

Coded 1 KAB, the series has current rating of 1.2 A into a resistive load, and 1.0 A if the load is capacitive.

Correct mounting orientation is ensured by the use of a 9.5 x 9.5 x 8.0 mm polarised package, which is particularly useful when checking load identification on densly populated PCB assemblies. The leads are on a standard 2.54 mm grid.

The range is equivalent to the B . . C1000 series of DIN bridges and may also be used as superior replacements for the B . . C500 and B . . C800 devices.

The 1 KAB is offered over the voltage range 100 to 1000 V VRRM. The product data sheet gives useful application information and a cross reference to the DIN types, as well as full details of the device specification.



Typical applications would be in general purpose power supplies, auxiliary supplies in power equipment, low current battery chargers, communications systems and the entertainment industry.

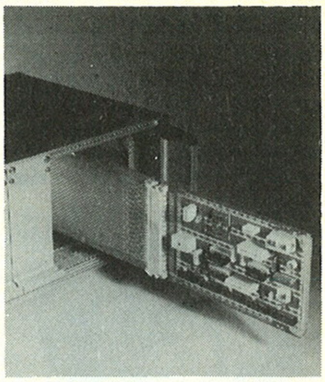
International Rectifier Co.,
(G.B.) Ltd.,
Hurst Green, Oxted, Surrey.

(923 M)

Circuit testing in the open

Testing circuits while your equipment is in operation is at best difficult and at worst impossible. To ease the problem Vero Electronics Limited have introduced two Eurocard compatible extender boards to complement the Vero Eurocard System 4.

They are 100 mm wide x 263 mm long – one carries 64/64-way plug and socket to DIN 41612, the other a 64/96-way plug and socket.



Included in the kit with each board are 20 terminals that can be assembled into pre-drilled holes in the board for test points.

Both boards are manufactured from Epoxy Glass.

Vero Electronics Limited,
Industrial Estate, Chandler's Ford,
Eastleigh, Hampshire. S05 3ZR.

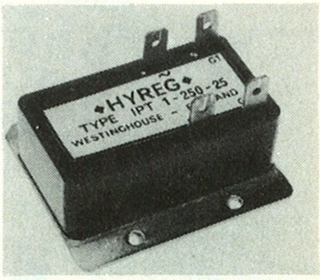
913 M)

New hyreg module

Westcode Semiconductors of Chippenham announce a new addition to their popular range of Hyreg module units.

Called the IPT 1/250-25, a single-phase basic ac regulator module, it has been developed to control loads of up to 6.25 kW from a mains supply and features a 10 mSec surge rating of over 210 amperes.

The high overcurrent and I^2t ratings make this unit especially attractive for the control of loads with heavy starting currents such as stage lighting, motors or transformers.



This module employs a ceramic substrate bonded to an isolated base plate and the whole is potted to provide a rugged module fully protected against a wide range of environmental conditions.

Westcode Semiconductors,
Chippenham, Wilts.

903M

MARKET

LCD multimeters

Two low cost LCD multimeters have been added to the existing range of N.L.S. DMM's.

The LM 300 has a 3 digit high contrast display powered by 3 AA size cells which can be either zinc-carbon or the optional nickel cadmium with an external mains adaptor. The 21 ranges cover AC and DC volts in 1-10-100-1 KV and AC DC current in 1-10-100-1000 mA ranges.

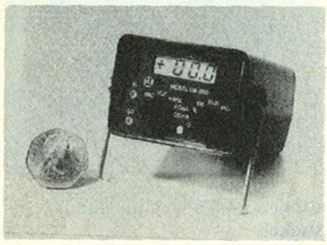
Resistance is measured in 5 ranges from 1 Kohm to 10 Mohm.

All ranges are fully protected and will withstand up to 1 Kv DC or AC peak on any voltage range.

The LM 350 is similar to the LM 300 but with a 3½ digit scale and 100% coverage.

Case size is only 1.9"x2.7"x4.0".

Price £ 74.00 (+ V.A.T.) for the LM 300 and £ 87.00 (+ V.A.T.) for the LM 350.



Lawtronics limited
139 High Street, Edenbridge,
Kent TN8 5AX.

(833 M)

Etch resist dry transfers

The Belgium company of Alfac are now marketing in England a range of about 100 different electro Symbols which will enable amateurs and industrial users to make up P.C.B.'s much more quickly, easily and accuately.

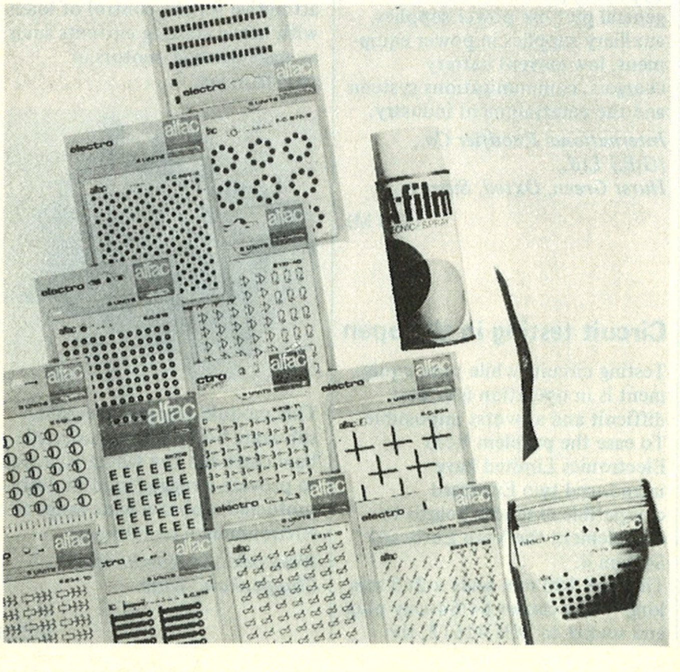
Alfac etch resist electro symbols can be transferred directly on to copper clad boards for making 'one-off' P.C.B.'s, or they can be used on drafting film to make electronic circuit diagrams. They are made in a range of component sizes, and they give exact and correct spacings for intergrated circuits and transistors.

Alfac transfers need no special fixing, since the double action adhesive prevents the symbols moving when they are laid down. The quality of the special ink which is used by Alfac eliminates any cracking, and a very professional finish can be achieved.

They are economical in price and are available in handy blister packs which are ideal for storage. Further details may be obtained from the Alfac sole agents in the U.K.

Pelltech Ltd., Alfac Electro
Division, 6 Church Green
Witney Nr. Oxford, England.

(839 M)



VSWR bridge

This VSWR Bridge has been specifically designed for use with transmitters capable of producing high power outputs. Unlike many of the other VSWR Bridges on the market, this particular piece of equipment will handle the high power without giving misleading results.

This so often occurs due to high sensitivity in order to read low power levels. When at high power levels the diodes which detect the sampled portion of R.F. energy become saturated and can no longer be relied upon to give a true reading.

With this problem in mind, the sensitivity of the instrument has been deliberately reduced.

The heart of the instrument is a double sided glass fibre printed circuit board with a printed stripline of a characteristic impedance of 50 ohms.

The forward and reflected power measurement is accomplished by means of a loosely coupled printed line with diodes at each end and a high quality carbon film "cermet" trimmer, to enable the instrument to be calibrated precisely, fixed at the centre point.

Connection to the 50 ohm stripline is by means of "N" type flange connectors with low inductance grounding of the body to the ground plane of the double sided printed circuit board.

The measurement of the voltage standing wave ratio is directly calibrated on a moving coil meter mounted on the front panel of the instrument, along with a sensitivity control to set full scale deflection on the forward range.

A miniature rocker switch switches between the forward and reflected detectors.

Specification:

Impedance	— 50 ohms
Sensitivity	— 5 Watts @ 432 MHZ 10 Watts @ 144 MHZ
Input/Output Connectors	— 'N' type UG 58/U
Maximum Power Levels	— 500 Watts @ 432 MHZ 1,000 Watts @ 144 MHZ

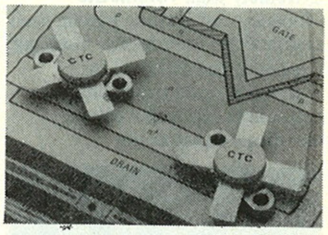
Polar Electronic
Developments Ltd.,
Domville Road,
Liverpool L13 4AT England.

(831 M)

Hi-power VHF V-FETs

A new range of vertical-geometry V-channel field-effect transistors, available in the UK from Walmore Semiconductors, can handle continuous-wave output powers of up to 100 W at frequencies of 175 MHz. The devices, manufactured by Communications Transistor Corporation, draw negligible d.c. input gate current, making biasing and modulation much simpler, and are much more rugged than comparable bipolar devices.

The new range of V-FET products, intended for r.f. amplifier applications, includes three devices — the BF25-35, BF50-35 and BF100-35 — designed to handle 25, 50 and 100 W of continuous-wave power, respectively. All the transistors are characterised for operation at either 80 or 175 MHz.



The ease of biasing and modulation, plus the ruggedness of the devices, are important features of the V-FET devices. The problems of thermal runaway or breakdown, sometimes encountered with bipolar transistors do not occur, and hence the devices are more tolerant of load mismatch.

The third-order distortion of the V-FET devices is similar to that of bipolar products, while the square-law-type characteristics of the V-FET technology gives a higher-order distortion figure 5 −10 dB lower than that for comparable bipolar devices.

Noise performance is also improved because the V-FET is a majority-carrier device.

The vertical V-channel structure allows a very narrow diffusion to take place, which leads to a good frequency response.

Interconnection of a large vertical area of tightly defined gates also allows the higher power levels to be achieved.

Maximum gain of the V-FET rf power transistors is 10 dB at 175 MHz. Breakdown voltage from source to drain is more than 65 V, and the source-to-gate breakdown voltage is more than 25 V. Typical 'on' resistance is less than 1 Ω measured at a 10 A drain current for the 100 W transistor.

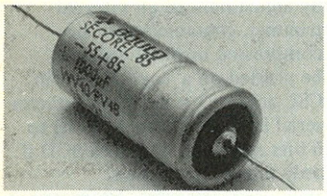
Walmore Semiconductors,
11-15, Betterton Street,
Drury Lane, London,
WC2H 9BS England.

(836 M)

MARKET

Smaller capacitor

A new range of aluminium electrolytic capacitors available from Gould Electronic Components Division is available in cylindrical aluminium cases with axial wires for easy mounting. Designated Secorel 85, the new capacitors range in size from 6.5 mm diameter and 15 mm long up to 25 mm diameter and are designed to fill an important need for high-performance capacitors in smaller size ranges. The Secorel 85 Series is a professional-grade range using a similar standard of construction and the same advanced electrolyte as the established Gould Prosec and Indel ranges. Eight sizes are available, with capacitance values ranging from 1 μF to 22 000 μF and voltages from 6.3 V to 350 V d.c.



Allied ranges with very low equivalent series resistance, designed for use at the high frequencies encountered in switch-mode power supplies, are the Secorel 032 and FRS Series. The 032 range is available with working voltages from 6.3 V to 100 V d.c. and capacitances from 6.8 μF to 1000 μF, and offers the same capacitance/voltage per can size as the Secorel 85. The FRS range provides even lower equivalent series resistance, but at some sacrifice of capacitance/voltage per volume.

Operating temperature range of Gould Secorel capacitors is −55°C to +85°C, capacitance tolerance is −10%, +50%, and shelf life is 3 years. Because of their low leakage current and good stability, Gould Secorel capacitors can be used in time-constant, timing, differentiation and integration circuits in addition to the usual coupling, decoupling and smoothing applications.

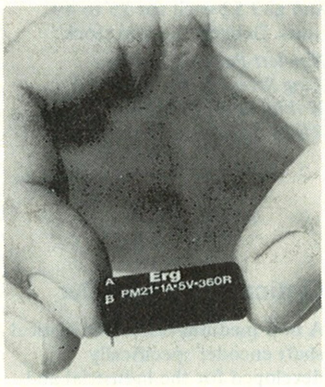
Gould Electronic Components Division,
Rhosymedre,
Wrexham, Clwyd.

(914 M)

Midget power reed relay

Despite measuring only 25 mm long by 8 mm wide, the Erg PM 21 midget reed relay can switch up to 20 W, both a.c. and d.c. Coil power required is only 70 mW. This 1 Form A (n.o.) s.p.s.t. component has a switching rate of 1000 Hz. Initial contact resistance is 50 mΩ max. and insulation resistance 10^{12} Ω. Off-the-shelf 10 W versions of the Erg PM 21 reed relay have contacts rated at 200 V 0.5 A (1A carry), with initial contact resistance of 200 mΩ and insulation resistance 10^8 Ω.

Insulation resistance between reed and coil (for both versions of the PM 21) is 10^{10} Ω min. at 500 V d.c. min., while dielectric strength between reed and coil is 500 V r.m.s. min. The relays are completely encapsulated with leadout pins set on a standard 0.1in. pitch for p.c.b. mounting. All relays incorporate internal magnetic screens. These minimise interaction from adjacent relays to only 10% of the "just operate" voltage when a relay is mounted between two similar relays with 0.1in. spacing. Weight of the PM 21 is just 3 gm. It is available in coil voltages of 5, 12 and 24 V and the relays will work satisfactorily with a ± 10% voltage variation. Vacuum-encapsulation in epoxy resin with glassloaded shells and headers gives reliable protection even in unfavourable environments. The PM 21 relays are designed to conform to the requirements of draft BS 9512. Special versions of the PM 21 are available to order. Price of the relay is around £ 1 dependent upon quantity.

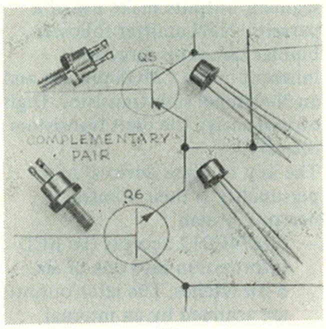


Erg Industrial Corporation Limited,
Luton Road, Dunstable,
Bedfordshire LU5 4LJ.

(922 M)

Complementary transistors

Eight new PNP and NPN transistors with 80 V collector-emitter voltages, 5 A continuous collector currents and operating frequencies to 70 MHz, provide high-performance in power amplifier and switching circuits. Developed by Solid State Devices, Inc., the 2N5002, 2N5005, 2N5151 and 2N5153 PNP transistors have 100 V collector-base voltages, 2 A continuous base currents and emitter-base voltages of 5.5 V. The 2N5003 and 2N5151 have static forward-current transfer ratios of 30 minimum to 90 maximum @5 V V_{CE} and 2.5 A I_C. The 2N5003 and 2N5153 have a transfer ratio of 70 minimum and 200 maximum with the same drive conditions. Typical turn-on time is 0.5 μsec while turn-off time is 1.3 μsec.



The NPN devices, 2N5002, 2N5004, 2N5152 and 2N5154, have similar electrical ratings permitting their use in complementary-pair circuits.

For broad safe-operating areas, the devices have a 15 mJoule reverse-energy rating. The 2N5002 to 2N5005 devices, packaged in the TO-59 case, have a continuous dissipation of 50 W @50°C case temperature. The 2N5151 to 2N5154 in TO39 packages are rated at 10 W @ 50°C case temperature.

Solid State Devices, Inc.,
14830 Valley View Avenue,
La Mirada, California 90638 USA.

905 M

Static invertor

A new static invertor from Bandenburg Ltd., the Model 060-02, is specifically designed as a prime power source for the Hawker Siddeley HS748 aircraft, and is ideal for retrospective fitting in place of the conventional rotary invertor. The 060-02 meets BS 3G100 specifications on shock, vibration and humidity, and is supplied with a mounting tray designed to fit the HS748.

Because the 060-02 static invertor is a purely electronic device with no moving parts, it avoids the problems of wear and maintenance which traditionally occur with electromechanical invertors. The invertor provides a 3-phase output of 1500 VA total rating from a nominal 28 V d.c. supply; each output is rated at 500 VA at 115 V, 400 Hz and phase-shifted by 120°.

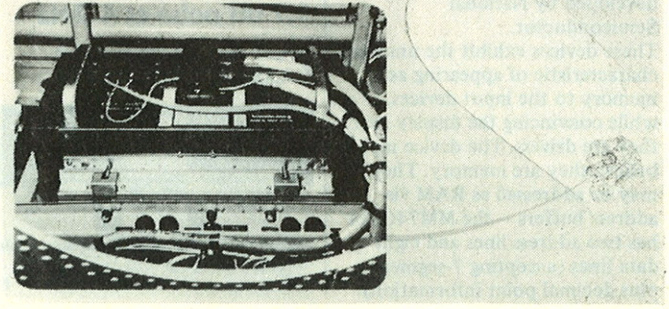
Output voltage and frequency are maintained constant over a wide range of input voltages, loads and environmental conditions, and the unit maintains a balanced output voltage even where there is a high degree of load imbalance. The 060-02 is of rugged design to ensure trouble-free operation under the conditions of shock and vibration normally encountered in civil aircraft, and cooling by natural convection.

The output voltage on each phase is maintained at 115 V ± 1.5 V r.m.s. over the normal input voltage range, and the output frequency is 400 Hz ± 4 Hz over the full operating temperature range of −35°C to +55°C at ground level, or −20°C to +45°C at altitudes of up to 15.2 km. The total harmonic content of the output does not exceed 5% with a 1500 W resistive load for normal input voltages.

Brandenburg Ltd. has approval from the Civil Aviation Authority under the Air Navigation Order for the supply of equipment used in civil aircraft.

Brandenburg Limited,
High Voltage Division,
939 London Road,
Thornton Heath,
Surrey, CR4 6JE.

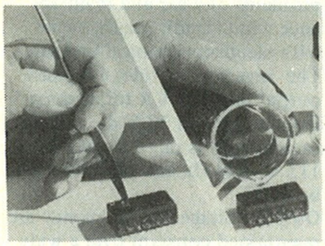
(911 M)



MARKET

Transparent epoxy elastomer

Eccogel 1265 is a two part epoxy resin which will cure at room temperature to a clear tough, but flexible solid. Eccogel 1265 bonds well to most substrates and is therefore useful as a flexible interface between dissimilar materials. Typical of this type of application is the bonding of safety screens to cathode ray tubes.



Cured Eccogel 1265 is sufficiently flexible that a ½" square, 12" long rod can be tied in a knot, and this allows the material to be used for the encapsulation of pressure sensitive devices, or delicate components such as fluorescent tubes.

When first mixed Eccogel 1265 has a very low viscosity and will readily impregnate components and will also produce bubble free castings. The cured material may be cut open and faulty components removed. Repair is effected by refilling the cavity with fresh material.

Eccogel 1265 also exhibits excellent vibration damping properties.

The photograph shows how a circuit module encapsulated with Eccogel 1265 is cut with a knife, repaired and resealed with Eccogel 1265.

Emerson & Cuming (U.K.) Ltd,
Colville Rd., Acton, London W3.

904 M

First schizophrenic CMOS IC

A unique pair of CMOS "Display Controller" IC's, the MM74C911 and MM74C912, have been developed by National Semiconductor.

These devices exhibit the unusual characteristic of appearing as memory to the input devices, while convincing the display that they are drivers. The device inputs believe they are memory. They may be addressed as RAM via address buffers – the MM74C911 has two address lines and eight data lines (accepting 7-segment plus decimal point information) whilst the MM74C912 has three address lines and five data lines (accepting BCD plus decimal point information).

The outputs, however, are convinced they are drivers – and to prove it they are multiplexed to drive 4-digit (MM74C911) or 6-digit (MM74C912) LED or gas discharge 7-segment displays. The segment outputs will drive up to 100 mA each. This is achieved using a buffered guard bank CMOS process in which the segment outputs make use of a parasitic NPN emitter follower bipolar transistor structure inherent in the CMOS process and an N-channel sink transistor. Digit outputs drive the digit transistors directly.

The key to these devices' split personality is their 'Central nervous system':

- MM74C912 accepts the BCD information into one of six 5-bit latches. The latch outputs are scanned by an internal oscillator, decoded to 7-segment format by a 16 x 7 Read Only Memory (ROM), and fed to NPN segment drivers. Segment outputs can be TRI-STATED – especially useful for display blanking in a standby power mode.
  MM74C911 operates similarly, except that the 8-bit input data after latching is fed directly to the segment drivers, without further decoding.
  This device is capable of digit and segment expansion. For example, two 74C911's can be cascaded to drive a 16-segment alphanumeric display.

Chip size is 130 x 130 mil, and both devices come in 24 pin DIL packages.

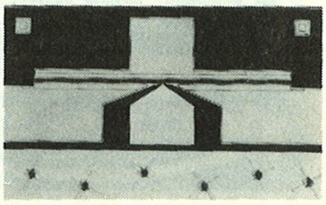
Applications include microprocessor display buffers, clock systems, silent hospital paging systems, personalised message receivers and pin-ball machines.

National Semiconductor Ltd.,
301 Harpur Centre, Horne Lane,
Bedford, MK40 1TR.

(908 M)

1.7 dB noise at 4 GHz

A new packaged microwave GAAS FET with the lowest guaranteed noise figure at 4 GHz in the industry and superior gain characteristics has been introduced by Hewlett-Packard.



The new HFET-1102 Low Noise Transistor has a guaranteed 1.7 dB maximum noise figure at 4 GHz and a useful range from 1 to 12 GHz. This low noise performance makes the HFET-1102 ideal for use in critical first stage microwave receiver/amplifier applications in land and satellite communications, radar, avionics and ECM.

In addition to its quiet performance, the HFET-1102 has a high minimum associated small signal gain of 11.0 dB at 4 GHz, which should minimize distortion even at the moderate power levels at which the device can be operated.

The new transistor is packaged in the hermetically sealed HPAC-100A for rugged, reliable performance in demanding applications.

Price of the HFET-1102 is £104.40 each for 1 to 9 units; £91.87 each for 10 to 24 units; and £83.52 each for 25 to 49 units. Delivery is from stock.

Hewlett-Packard Limited,
King Street Lane, Winnersh,
Wokingham, Berkshire.
RG11 5AR

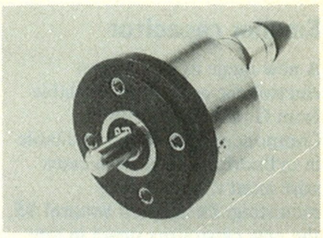
901 M

Optical shaft encoder

A new medium-resolution optical shaft encoder specifically developed for the industrial and instrument markets, has been introduced by the Ferranti Industrial Components Group, Dalkeith. Known as the Ferranti Model 24 ST encoder, it has a stainless steel shaft carried on ballbearings and a stainless steel protective can. It is mechanically robust and well protected. In addition, a tough optical plastic disc is used in preference to glass, for increased resistance to shock.

A powerful output drive stage gives a high degree of immunity to noise and a unique low-level operation LED circuit provides an extended life expectancy compared with conventional units.

The counting range extends between 200 and 635 lines per revolution. Dual outputs in quadrature and a once per revolution marker pulse, all at 5 volt logic levels, are offered as standard. Operation at up to 10,000 r.p.m. is specified for normal life application. The Ferranti Model 24 ST encoder is a medium-resolution unit that provides all-round mechanical and electrical reliability.

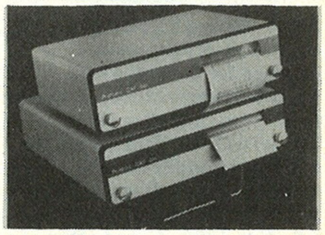


Industrial Products Department,
Ferranti Limited,
Thornybank Trading Estate,
Dalkeith, Midlothian,
EH22 2NG.

(915 M)

Alphanumeric printer

The Printina CSC is a 24-column alphanumeric printer. However, by adjustment of an internal trimmer, characters may be compressed until 32 columns be printed on a single line. The CSC accepts bit parallel character serial inputs coded according to 6 bits ASCII, or to 4 bits BCD if only numbers are used.



Fastest print rate is 1.2 lines/second at 5.2 power supply (the unit will operate from 5 V ± 5% or 6-8 V d.c.). Write time is approximately 400 ms. Life is estimated at 10^6 lines without service.

The printer uses standard rolls of metallised electro-sensitive paper. A roll 25 metres long allows 5,000 lines to be printed. Paper flow is downwards. The paper roll is stored internally and a new roll can be fitted easily in a matter of seconds.

One of the most rugged printers available, the CSC can withstand the most severe environmental conditions.

Price of the Printina CSC is only £195 (25+) and it is also available without case as a single p.c.b. printer for O.E.M. applications. Housed in a cabinet measuring 54 x 192 x 130 mm, the printer weighs only 1 kg.

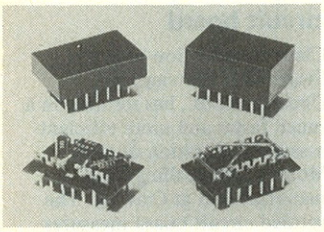
Seltek Instruments Limited,
Hoddesdon Road,
Stanstead Abotts,
Herts SG12 8EJ.

(910 M)

MARKET

Multi-purpose DIL package

The new Erg DILpack 14 is a low-profile multi-purpose DIL packaging component. Basically a precision-moulded 14-pin DIL skeleton package, it offers a choice of two tight-fit, snap-on covers giving a 5.7 mm or 8.9 mm height profile, and can house numerous components. Because of the close tolerance and tight fit of the covers, components may be encapsulated easily. The Erg DILpack plugs directly into any standard 0.1 in. hole spacing; either a DIL socket or directly onto a p.c.b. for flow soldering. The two rows of 7, linked terminals may be individually disconnected using only wire cutters, and can be linked and/or cross-linked with direct soldered connection wires. This feature allows the DILpack to be used for preparing programme addresses.



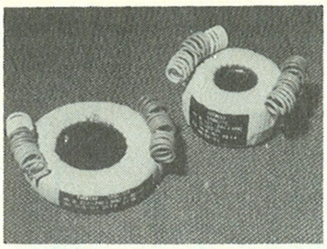
Hybrid circuits and/or passive networks may be built inside and fully protected from environmental hazards. Using ribbon or regular 14-way cable with an Erg DILpack at each end provides a simple and inexpensive means of reliable board-to-board coupling. Moulded in glass reinforced nylon, these packaging components can be used in the temperature range −55°C to +100°C. Both connections and pins are hard gold plated. Delivery is ex stock. Price 25p each (100 rate).

Erg Industrial Corporation Limited,
Luton Road,
Dunstable, Beds LU5 4LJ.

(916 M)

Variable geometry power transformers

Parmeko Ltd have developed a range of toroidal power transformers based on a variable geometry concept. This allows variations in dimensions for transformers of a given rating to fit them within confined spaces and thereby overcome one of the major problems facing users of electronic circuits.



Recent developments in 'micromin' electronics now demand smaller inductive components for a given electrical rating. Designers faced with this 'quart into a pint pot' problem will be helped considerably by the introduction of the Parmeko 5500 series of toroidal power transformers.

Compared to conventional laminated transformers of a similar rating, transformers of toroidal construction typically save about 45% of the volume and can reduce the height even more significantly. The variable geometry concept takes these space savings a stage further. It allows the shape to be changed in three ways: by altering the ratio of height to diameter; by selecting a small core with the winding space fully utilised; or by using a larger core with only part of the winding space utilised.

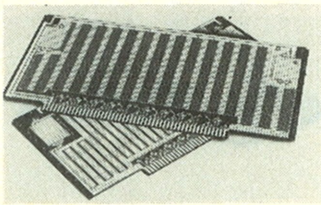
The 5500 series covers a power range at 50 Hz of up to 1 KVA, and within the overall range there is a selection of standard toroidal power transformers to cover popular applications with shorter lead times.

Parmeko Limited,
Percy Road,
Leicester LE2 8FT

(924 M)

S100 Universal Microprocessor/Microcomputer prototyping board

Following the increasing use of the S100 board size and bussing system in microcomputers (e.g. Attair 8800, IMSAI 8080) and microprocessor applications, Vero Electronics Limited announce the release of a universal S100 bus-compatible prototyping board. This board is designed for the manufacture or breadboarding of microprocessor, memory or interface assemblies, and will, without modification, mount directly into any equipment using the S100 bus system.



The layout of the Vero S100 prototyping board has been optimised for maximum flexibility in use and as a memory board will hold up to fifty-two 16-way DIP's (equivalent to 6K of memory) or in more general use, thirty-six 16-way plus eight 24-way plus two 40-way packages, making it ideal for microcomputer expansion and general digital and analogue circuits.

The board has an S100 edge connector configuration (i.e. 100 gold-plated contact fingers on 3,175 mm/0.125 inch pitch) and is fully pierced with 1,02 mm/0.040 inch diameter holes on a 2.54 mm/0.1 inch matrix. Provision is made for mounting up to four standard TO-220 plastic package regulators together with heatsinks for on board regulation, and the voltage plane is capable of being divided to provide up to four separate positive or negative supply rails.

The component side of the board carries a ground plane which can be used for terminations or screening and the wiring side carries both voltage and ground planes, thus providing for up to five planes.

The board is intended primarily for interconnection by wire wrap methods, although connections can be made directly from wire wrap pins to the ground and voltage planes by use of the Vero 'Z' links. Alternatively the board can be used for soldered connections by using the Verowire pen which wraps a solder through insulated wire around the pins of solder spill DIP sockets.

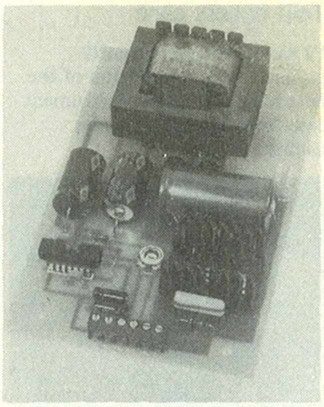
A wide range of compatible standard accessories such as DIP sockets, pins, headers, ribbon cables etc., is available enabling the Vero S100 prototyping board to cope with virtually any microprocessor or microcomputer circuit requirement.

Vero Electronics Limited,
Industrial Estate, Chandler's Ford
Eastleigh, Hampshire SO5 3ZR.

(917 M)

3-Rail power supply

A three-rail Eurocard power supply announced by Lascar Electronics is claimed to be suitable for most circuits where digital and linear devices are mixed. They may also find application as micro-processor power supplies.



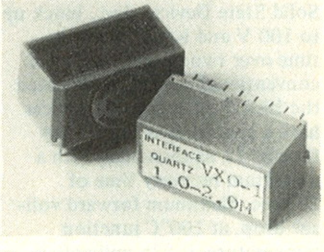
The supply features one output of 5 V 1000 mA, and dual tracking outputs adjustable between ±5 V with a maximum of 100 mA per rail. The 5 V and twin-rail supplies are isolated from each other and feature short-circuit, over-temperature and fold-back over-current protection. Input voltages 220 V a.c. or 240 V a.c. The supply is fitted with terminal blocks on the input and outputs, and is assembled on a PCB measuring 160 x 100 mm, with a maximum height of 47 mm.

Lascar Electronics Limited,
P.O. Box 12, Module House,
Billericay, Essex CM12 9QA.

902 M

Crystal Oscillators

Verospeed, the Vero Group's rapid despatch service, now have two DIP Packaged Crystal Oscillators included in their range of general electronic components.



Both are TTL compatible. One has normal and complementary outputs at 1.0 and 2.0 MHz and the other has a single 10 MHz output. Priced at £ 9.36 and £ 11.96 respectively they are both becoming widely accepted in the electronics industry.

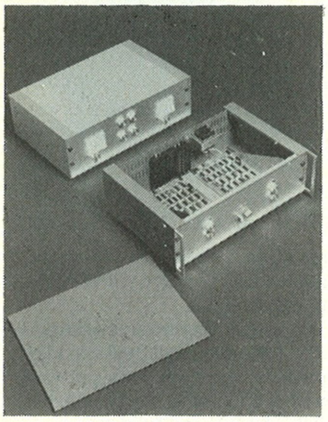
Verospeed
Barton Park Industrial Estate,
Eastleigh, Hampshire, SO5 5RR
England

(855 M)

MARKET

Top access case

12 variations are currently available of a new version of the best selling 'D' Series instrument case from Vero Electronics Limited.



It features quick and easy access to the top of the case by removing 2 screws which release the top panel – ideal for microprocessor applications or chassis-mounted equipment, where immediate access is required.

Multiple front panel fixing, anti-slip feet and four optional colour finishes are further features of the range.

Vero Electronics Limited,
Industrial Estate, Chandler's Ford,
Eastleigh. Hampshire, S05 3ZR.

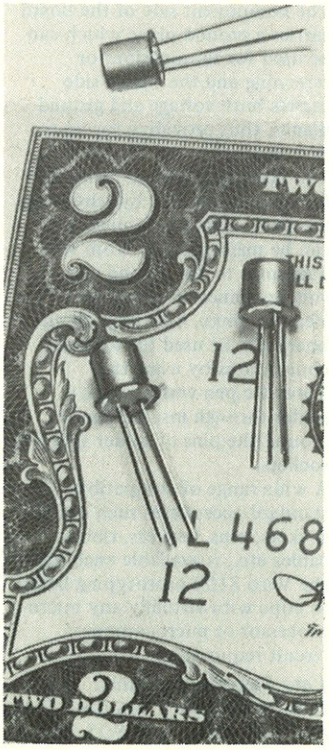
(912 M)

Miniature 6 A rectifiers

A new line of miniature 6 ampere ion-implanted rectifiers, from Solid State Devices, Inc., block up to 100 V and have a recovery time over two times faster than conventional devices. Designated the HSR-2-52 series, the devices have a typical reverse-recovery time of 15 nanoseconds with a maximum recovery time of 20 nsec. Maximum forward voltage drop, at 100°C junction temperature, is 825 millivolts; maximum reverse-leakage current is 20 microamperes.

By comparison, conventional high-speed rectifiers have a typical reverse-recovery time between 30 nsec and 50 nsec with forward drops of about 1 V. Typical reverse-leakage current is approximately the same as the HSR-2-52. Thought to be the smallest in their current and voltage range, the HSR-2-52 series devices measure only 0.15 inches high by 0.25 inches in diameter. The key to their high-power dissipation is packaging assembly. The die is eutectically bonded to a modified TO-18 transistor case which, along with one lead, serves as a high-current anode. The two other leads are ultrasonically bonded to the cathode with dual 10 mil wire.

Manufactured using SSDI's patented EPION^R ion-implanted process, the devices are radiation hardened. This occurs because their low carrier lifetime permits operation at higher switching frequencies with lower forward-voltage drops. In addition, the small (70 mil square) device geometrically contributes to radiation tolerance. There are seven devices in the HSR-2-52 series with maximum peak-repetitive reverse voltages from 20 V to 100 V; maximum root-mean-square voltages are 15 V to 70 V. For all devices, average one-half wave rectified current is 6 A, with nonrepetitive surges to 125 A. Operating temperature range is –55°C to +175°C.

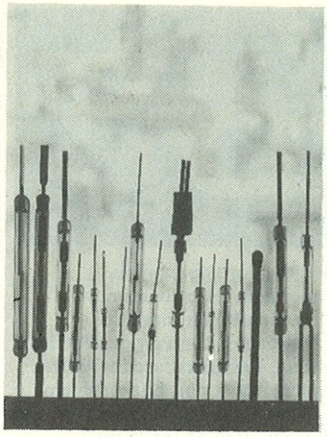


Solid State Devices, Inc.,
14830 Valley View Avenue,
La Mirada, CA 90638 USA.

(906 M)

A match for any switch!

A 'rogue' matchstick lines up with a collection of tiny reed switches – ranging from 0.47 in. to 2.070 inches in length (11.6 mm-52.5 mm) – that can perform over one hundred electronic operations per second.



Made by a leading British company, the reed switch is a glass-encapsulated device in which the moving parts are cantilevered blades known as 'reeds'. These reeds are made of ferromagnetic material and are arranged so that their ends overlap, normally with a small air gap between them. The switch is operated by supplying an external magnetic field, which causes the blades to be attracted together to make contact.

The simplicity of operation and the sealed environment in which they work gives the switches a long life – up to 100 million operations – and a very high degree of reliability.

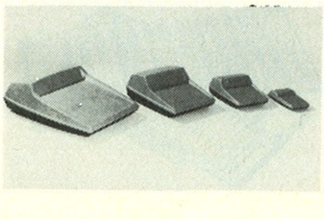
Reed switches are initially found in areas where high speed and miniaturisation are significant factors. Telecommunications and data processing are two examples. They can also be found in power system controls, office machinery, anti-theft devices and vending and amusement machines.

Astralux Dynamics Ltd.,
Brightlingsea, Colchester, Essex,
CO7 OSW, England.

(907 M)

Neat cases

A case for micro-processors, data terminals, calculators, etc. has been produced in four sizes by West Hyde. This range of four cases has been designed by R. Fran Sutton, M.S.I.A, N.R.D. The features include the correct angle of the keyboard and data display, the space to take Eurocards or double Eurocards, power supplies, etc., the connections to remain hidden; and a second steeper slope for displays or meters.



Produced in leather-grain black and tan or all leather-grain shiny black A.B.S., the cases are ex-stock and the prices include feet.

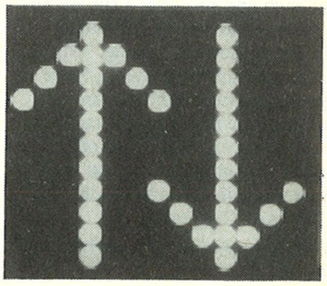
Prices from £ 3.90 for one off for the smallest size, with big quantity discounts.

West Hyde Developments Ltd.,
Unit 9, Park St. Ind. Est.,
Aylesbury, Bucks. HP20 1ET.

(928 M

Largest UK printed circuit board

Close co-operation between Stone Platt Crawley, and Circaprint Ltd., has resulted in a much faster and more efficient assembly operation of their Motorway Signalling Units manufactured at Crawley. The printed circuit board measures 22" x 26" and has 5,200 drilled holes, it carries 520 diodes, 137 lamp holders, and there are 1,600 soldered joints made in one flow solder pass.



The printed circuit board is made exactly to a high specification, however, owing to its large size a special jig has been developed by Stone Platt, to ensure perfect flatness when it passes over the solder wave, resulting in less than a half per cent of dry joints.

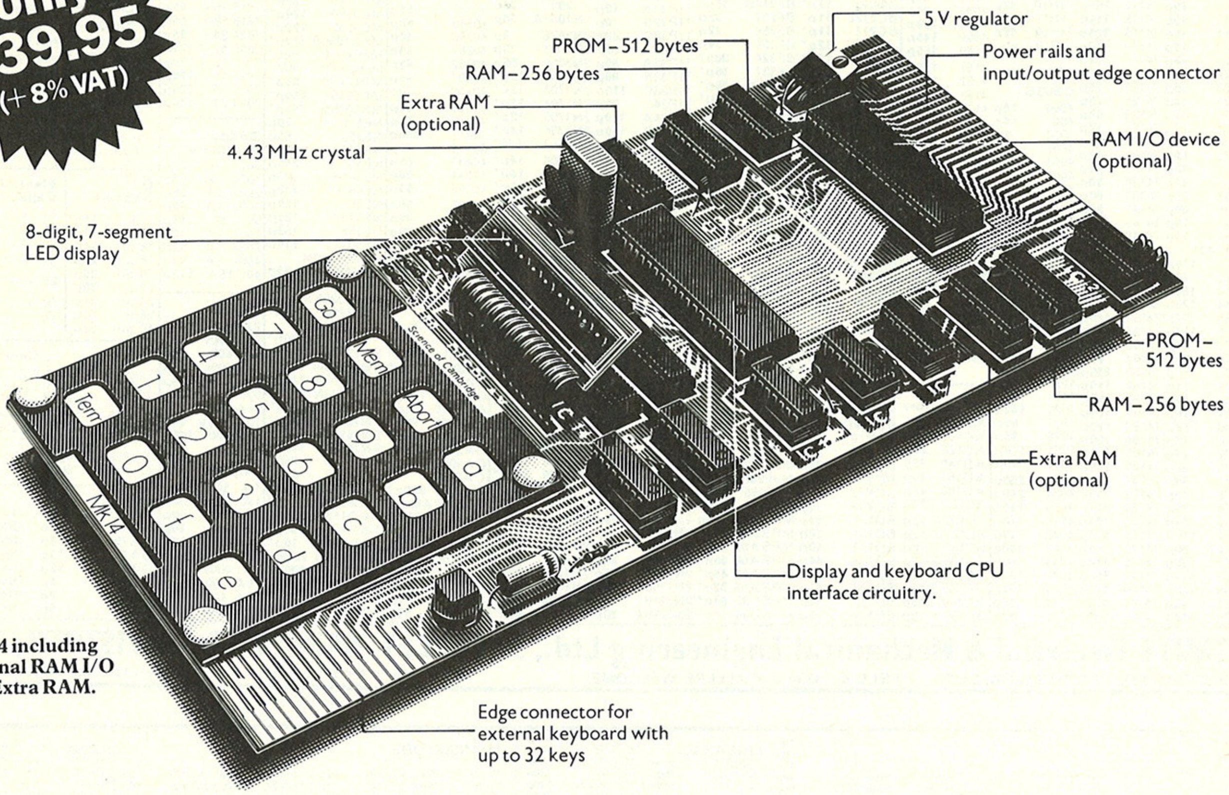
Circaprint supply conventional and Plated Through Hole printed circuit boards to numerous leading British Companies for application ranging from Brain Scanners to Automatic Telephone Exchanges.

Circaprint Ltd.,
Foster Street,
Maidstone,
Kent.

(920 M)

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only
£39.95
(+8% VAT)


5 V regulator
PROM – 512 bytes
Power rails and input/output edge connector
RAM – 256 bytes
Extra RAM (optional)
4.43 MHz crystal
RAM I/O device (optional)
8-digit, 7-segment LED display
Go
Mem
Abort
Term
7
8
9
4
5
6
1
2
3
0
a
b
c
d
e
f
MK 14
Science of Cambridge
PROM – 512 bytes
RAM – 256 bytes
Extra RAM (optional)
Display and keyboard CPU interface circuitry.
Edge connector for external keyboard with up to 32 keys

MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory – and peripherals!

Optional extras include:

1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

●Hexadecimal keyboard ● 8-digit, 7-segment LED display ● 8 x 512 PROM, containing monitor program and interface instructions ●256 bytes of RAM ● 4 MHz crystal ● 5 V regulator ● Single 8 V power supply ● Space available for extra 256-byte RAM and 16 port I/O ● Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Please send me the following, plus details of other peripherals:

☐ MK 14 Standard Microcomputer Kit @ £43.55 (inc 40p p&p.)
☐ Extra RAM @ £3.88 (inc p&p.)
☐ RAM I/O device @ £8.42 (inc p&p.)

I enclose cheque/money order/PO for £__________ (indicate total amount.)

Name__________
Address (please print)__________
____
____
____
____

Allow 21 days for delivery.

Science of Cambridge

TTLs

7400	13p
7401	14p
7401AN	15p
7402	16p
7403	16p
7404	20p
7405	25p
7406	40p
7407	40p
7408	22p
7409	22p
7410	18p
7411	26p
7412	25p
7412AN	28p
7413	40p
7416	40p
7417	40p
7420	18p
7421	43p
7422	28p
7423	36p
7425	33p
7426	43p
7427	40p
7428	40p
7430	18p
7432	38p
7433	44p
7437	38p
7438	38p
7440	18p
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7454	18p
7460	18p
7470	38p
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7473	36p
7474	38p
7475	43p
7476	38p
7480	54p
7481	110p
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74107	36p
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74110	60p
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74116	220p
74118	110p
74119	225p
74120	130p
74121	32p
74122	54p
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74136	80p
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74150	130p
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74156	96p
74157	98p
74159	250p
74160	110p
74161	110p
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74181	320p
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74191	120p
74192	99p
74193	99p
74194	160p
74195	110p
74196	100p
74197	130p
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74199	250p
74221	175p
74H00	85p
74H05	45p
74H10	42p
74H11	44p
74H20	42p
74S10	40p

CMOS

4000	18p
4001	18p
4006	95p
4006	18p
4008	120p
4009	50p
4010	60p
4011	18p
4012	18p
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4419	280p
4422	550p
4433	1250p
4435	800p
4450	290p
4451	290p
4501	95p
4502	120p
4503	65p
4506	50p
4507	55p
4508	295p
4510	95p

Transistors

AC107	24p
AC127	20p
AC128	20p
AD149	70p
AD161	45p
AD162	45p
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	12p
BC109	10p
BC109B	12p
BC109C	12p
BC147	9p*
BC148	9p*
BC149	10p*
BC157	10p*
BC158	10p*
BC159	11p*
BC169C	14p*
BC172	12p*
BC177	17p*
BC178	17p
BC179	18p
BC182	10p*
BC183	10p*
BC184	11p*
BC187	30p
BC212	11p*
BC212L	11p*
BC213	11p*
BC213L	12p*
BC214	13p*
BC214L	13p*
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BC237A	16p*
BC237B	16p*
BC238	16p*
BC238A	16p*
BC238B	16p*
BC238C	20p*
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BC337	18p*
BC338	16p*
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BC559B	18p*
BC559C	18p*
BCY70	18p
BCY58	22p
BCY59	22p
BCY71	22p
BCY72	22p
BCY78	20p
BD121	95p
BD131	50p
BD132	50p
BD133	44p
BD135	38p
BD136	37p
BD137	36p
BD139	36p
BD140	36p
BD234	70p
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BF240	18p*
BF241	18p*
BF244B	35p*
BF257	35p
BF258	32p
BF259	36p
BF324	36p*
BF337	36p*
BFR39	30p*
BFR40	30p*
BFR41	30p*
BFR52	20p
BFR79	30p*
BFR80	30p*
BFR81	30p*
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BFX85	30p
BFX86	30p
BFX87	30p
BFX88	30p
BFY50	22p
BFY51	22p
BFY52	22p
BFY90	90p
BRY39	45p
BSX19	20p
BSX20	20p
BU105	180p*
BU108	250p*
BU204	230p*
BU205	220p*
BU208	240p*
BU406	145p*
C1509	15p
MEO491	18p
MJE2955	100p
MJ2955	100p
MJE340	65p*
MJE3055	70p
MPS2369	20p
MPSA05	30p*
MPSA06	30p*
MPSA12	45p*
MPSA56	32p*
MPSU06	63p*
MPSU56	75p*
OC70	40p
OC71	45p
R2008B	200p*
R2010B	200p*
TIP29	50p
TIP29A	45p
TIP29B	50p
TIP29C	50p
TIP30	40p
TIP30A	48p
TIP30B	48p
TIP30C	60p
TIP31A	58p
TIP31B	58p
TIP31C	60p
TIP32	68p
TIP32A	68p
TIP32B	70p
TIP32C	82p
TIP33	90p
TIP33A	90p
TIP33B	90p
TIP33C	110p
TIP34	96p
TIP34A	110p
TIP34B	110p
TIP34C	155p
TIP35A	220p
TIP35C	280p
TIP36A	260p
TIP36C	330p
TIP41A	65p
TIP41B	80p
TIP41C	78p
TIP42A	70p
TIP42B	82p
TIP42C	82p
TIP2955	78p
TIP3055	70p
TIS43	34p*
TIS90	22p*
TIS91	25p*
TIS93	30p*
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ZTX300	13p*
ZTX500	15p*
ZTX502	180*
ZTX504	30p*
2N696	35p
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2N918	45p
2N930	20p
2N1131	20p
2N1132	20p
2N1613	25p
2N1711	25p
2N1893	35p
2N2218	28p
2N2218A	28p
2N2219	25p
2N2219A	28p
2N2221	20p
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2N2222	20p
2N2222A	20p
2N2368	20p
2N2369	18p
2N2369A	16p
2N2646	50p
2N2904	25p
2N2904A	28p
2N2905	25p
2N2905A	25p
2N2906	20p
2N2906A	24p
2N2907	28p
2N2907A	30p
2N2926	9p
2N3053	28p
2N3055	55p
2N3702	12p*
2N3703	12p*
2N3704	12p*
2N3705	12p*
2N3706	14p*
2N3707	140*
2N3708	14p*
2N3709	14p*
2N3819	25p*
2N3820	50p*
2N3823	70p*
2N3866	85p*
2N3903	18p*
2N3904	18p*
2N3905	20p*
2N3906	20p*
2N4036	65p*
2N4037	55p*
2N4058	12p*
2N4059	12p*
2N4060	12p*
2N4061	18p*
2N4062	18p*
2N4123	22p*
2N4124	22p*
2N4125	22p*
2N4126	22p*
2N4230	100p*
2N4236	150p*
2N4239	140p*
2N4240	150p*
2N4259	150p*
2N4286	18p*
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2N4288	18p*
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2N6027	48p*
2N6545	420p*
3N128	120p
3N140	100p
3N141	85p
3N201	110p
3N204	100p
40347	65p
40348	80p
40360	40p
40361	45p
40362	45p
40407	45p
40408	70p
40409	65p
40410	65p
40411	300p
40412	60p
40430	85p
40594	90p
40595	99p
40603	58p
40673	90p
40841	90p
40842	110p
40871	90p
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CA3140	98p
CA3160	98p
LM301AN	30p
LM318	200p
LM324	70p
LM339	85p
LM348	110p
LM380	95p*
LM381AN	145p*
LM732	125p*
LM733	100p
LM747	70p
LM748	35p
LM3900	65p
LM3911	125p
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MC1458	50p
MC1495	420p
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MC1103	95p
MC3340	120p*
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MC7242	120p*
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200v	2A	52p
400v	2A	60p
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2A	400v	75p
6A	100v	50p
6A	200v	65p
6A	400v	75p
10A	100v	75p
10A	200v	99p
10A	400v	120p

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74150	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	93p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	200p
74182	90p
74184A	150p
74185	150p
74186	700p
74190	100p
74191	100p
74192	100p
74193	100p
74194	100p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74265	90p
74278	290p
74279	140p
74283	190p
74284	400p
74285	400p
74290	150p
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74LS164	120p
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74LS174	110p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS195	140p
74LS196	120p
74LS221	100p
74LS240	245p
74LS241	245p
74LS242	245p
74LS243	245p
74LS244	200p
74LS245	200p
74LS251	200p
74LS257	120p
74LS259	175p
74LS273	130p
74LS298	249p
74LS324	200p
74LS365	160p
74LS367	160p
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4021	110p
4022	100p
4023	22p
4024	50p
4025	20p
4026	130p
4027	50p
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4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	130p
4047	100p
4048	55p
4049	32p
4050	49p
4051	80p
4052	80p
4053	80p
4054	140p
4055	125p
4056	135p
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4066	55p
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*BC157/8	10p
*BC159	11p
*BC169C	12p
*BC172	12p
BC177/8	17p
BC179	18p
*BC182/3	10p
*BC184	11p
BC187	30p
*BC212/3	11p
*BC214	12p
BC461	36p
BC477/8	30p
*BC516/7	50p
*BC547B	16p
*BC549C	18p
*BC557B	16p
*BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD242	65p
BDY56	200p
BF200	32p
*BF244B	35p
*BF256B	70p
BF257/8	32p
BF259	36p
*BFR39	30p
*BFR40	30p
*BFR41	30p
*BFR79	30p
*BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BYF56	33p
BFY90	90p
BLY83	700p
BRY39	45p
BSX19/20	20p
*BU105	190p
*BU108	250p
*BU205	200p
*BU208	240p
*BU406	145p
MJ481	175p
MJ491	200p
MJ2501	225p
MJ2955	100p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105/6	40p
*MPSA06	30p
*MPSA12	50p
*MPSA56	32p
*MPSU06	63p
*MPSU56	78p
OC28	130p
OC35	130p
*R2008B	200p
*R2010B	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP3055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
*ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N697	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	60p
2N2160	120p
2N2219A	20p
2N222A	20p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	20p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	12p
*2N3708/9	12p
2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
*2N4036	65p
*2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	27p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
*2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N692	65p
3N128	120p
3N140	100p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	65p
40410	65p
40411	300p
40594	97p
40595	105p
40603	58p
40673	75p
40841	90p
40871/2	90p

MEMORIES

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2102-2	140p
2107B	600p
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EPROMS

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2708	900p
2716	3000p
4702	900p

CPUs

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6502	1200p
6800	900p
8080A	650p

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3245	400p
4201	390p
4289	970p
4801	500p
6820	600p
6850	700p
8205	320p
8212	225p
8216	225p
8224	400p
8228	575p
8251	700p
8255	550p
9905	200p
9906	275p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p

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*2A	100V	35p
*2A	400V	45p
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*3A	600V	72p
*4A	100V	95p
*4A	400V	100p
6A	50V	90p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

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6A	500V	88p
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8A	500V	95p
12A	400V	85p
12A	500V	105p
16A	400V	110p
16A	500V	130p

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1A	400V	65p
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8A	600V	200p
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16A	100V	160p
16A	400V	180p
16A	600V	220p
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7413	25p	74123	40p
7414	48p	74125	35p
7416	24p	74126	35p
7417	24p	74132	50p
7420	12p	74141	56p
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7423	22p	74147	110p
7425	22p	74148	90p
7426	24p	74150	70p
7427	24p	74151	50p
7428	28p	74153	50p
7430	12p	74154	85p
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7433	32p	74156	52p
7437	22p	74157	53p
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AF125	27p	BD135	38p	ZTX504	25p	2N3819	22p
AF126	27p	BD136	36p	ZTX530	30p	2N3823	65p
AF127	27p	BD137	38p	ZTX550	24p	2N3824	75p
AF139	36p	BD138	38p	2N696	32p	2N3866	55p
AF239	40p	BD139	35p	2N697	12p	2N3903	8p
BC107	8p	BD140	35p	2N698	28p	2N3904	8p
BC107B	10p	BF244B	36p	2N699	50p	2N3905	8p
BC108	8p	BFX29	25p	2N706	13p	2N3906	8p
BC108B	8p	BFX84	23p	2N706A	13p	2N4037	30p
BC108C	10p	BFX87	20p	2N708	20p	2N4058	12p
BC109	8p	BFX88	20p	2N914	22p	2N4059	10p
BC109C	10p	BFY50	15p	2N918	30p	2N4060	12p
BC147	7p	BFY51	15p	2N919	50p	2N4061	12p
BC148	7p	BFY52	15p	2N920	54p	2N5179	50p
BC149	8p	BU105	170p	2N929	25p	2N5457	22p
BC157	9p	BU205	140p	2N930	20p	2N5458	30p
BC158	9p	BU208	160p	2N1131	23p	2N5459	32p
BC159	9p	MJ2955	98p	2N1132	23p	2N5777	50p
BC167	8p	MPF102	36p	2N1302	38p	**Diodes**	
BC168	8p	MPSA06	30p	2N1303	54p	OA47	10p
BC169	8p	MPSA56	30p	2N1304	54p	OA91	5p
BC169C	9p	TIP29	40p	2N1613	22p	OA200	6p
BC170	9p	TIP29A	44p	2N1671	130p	1N914	4p
BC171	9p	TIP29B	40p	2N2160	100p	1N916	5p
BC172	7p	TIP29C	60p	2N2243	28p	1N4001	4p
BC173	9p	TIP30	40p	2N2297	45p	1N4002	4p
BC177	14p	TIP30A	48p	2N2368	15p	1N4006	6p
BC178	14p	TIP30B	55p	2N2369	16p	1N4148	3p
BC179	14p	TIP30C	70p	2N2484	22p		
BC182	10p	TIP31	50p	2N2846	70p	**Regulators**	
BC182L	10p	TIP31A	50p	2N2904	22p		
BC183	10p	TIP31B	60p	2N2094A	23p	7805	60p
BC183L	10p	TIP31C	65p	2N2905	22p	7812	60p
BC184	10p	TIP32	55p	2N2905A	22p	7815	60p
BC184L	10p	TIP32A	60p	2N2906	22p	7818	60p
BC207	10p	TIP32B	75p	2N2906A	22p	7824	60p
BC208	8p	TIP32C	80p	2N2907	22p	78L05	30p
BC209C	10p	TIP33	75p	2N2907A	25p	78L12	30p
BC212	10p	TIP33A	80p	2N2926G	10p	78L15	30p
BC212L	10p	TIP33B	103p	2N2926R	8p	7905	80p
BC213	10p	TIP33C	116p	2N3011	22p	7912	80p
BC213L	10p	TIP34	98p	2N3053	18p	7915	80p
BC214	10p	TIP34A	95p	2N3054	50p	7918	80p
BC214L	10p	TIP34B	128p	2N3055	50p	7924	80p
BC477	19p	ZTX107	14p	2N3121	25p	79L05	70p
BC478	18p	ZTX108	14p	2N3133	25p	79L12	70p
BC479	18p	ZTX109	14p	2N3440	80p	79L15	70p
BC547	11p	ZTX300	16p	2N3441	120p	LM309K	110p
BC548	10p	ZTX301	16p	2N3442	135p	LM317K	300p
BC549	11p	ZTX302	23p	2N3702	8p	LM323K	530p
BC550	14p	ZTX303	23p	2N3703	8p	LM723	40p

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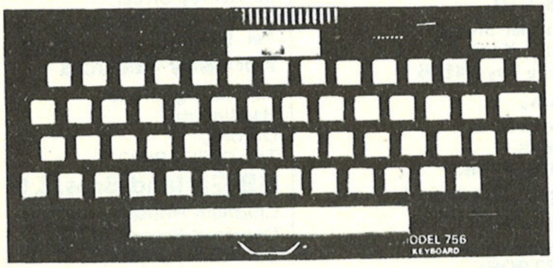

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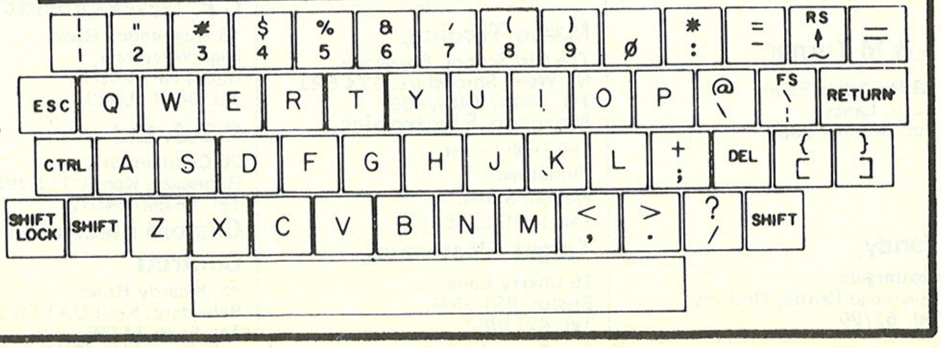

WHO and WHERE

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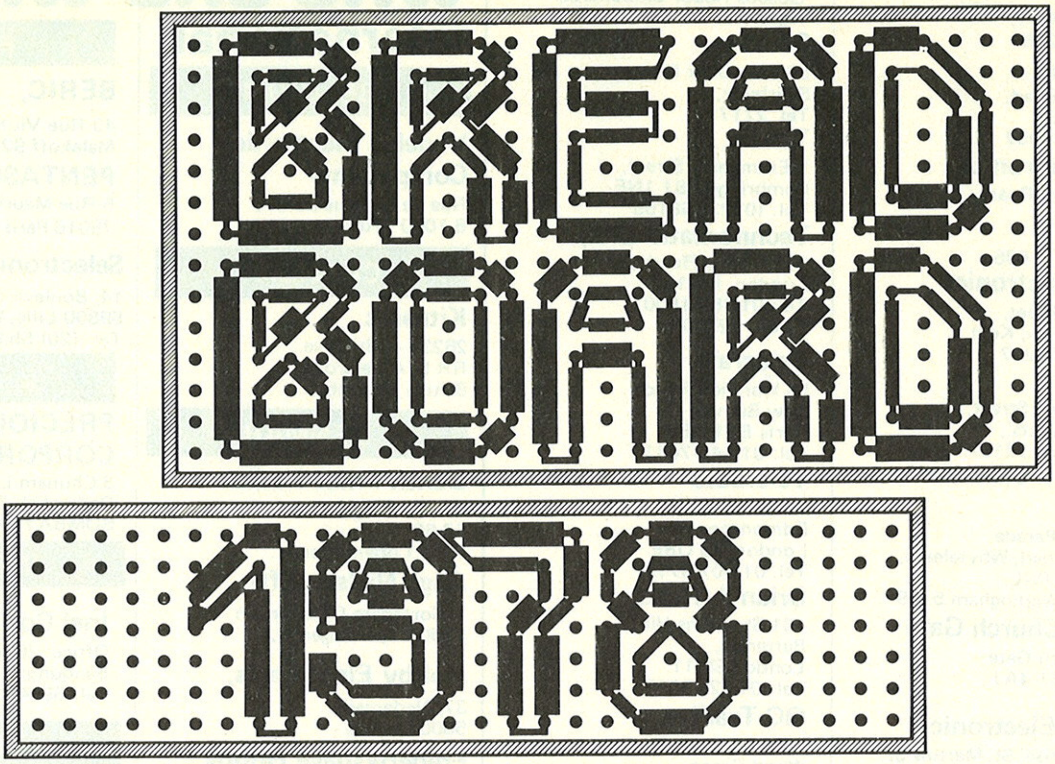

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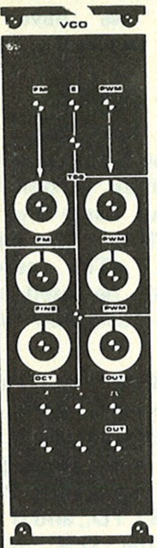

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All FORMANT PCBs are as published in ELEKTOR

ELEKTOR PIANO (Sept 1978)
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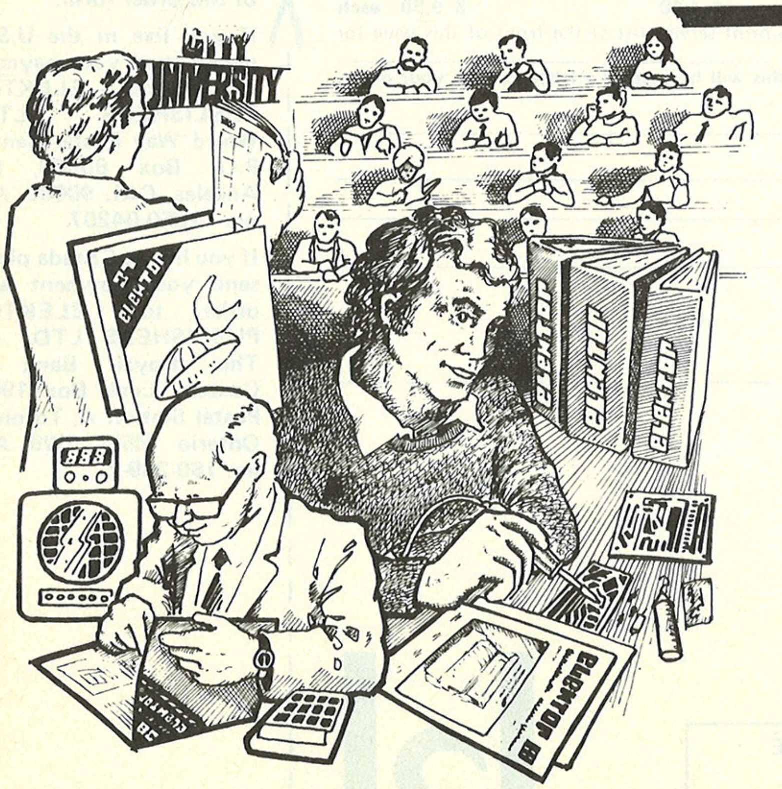

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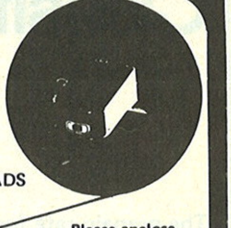

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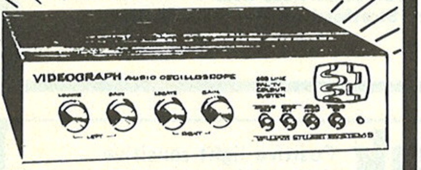

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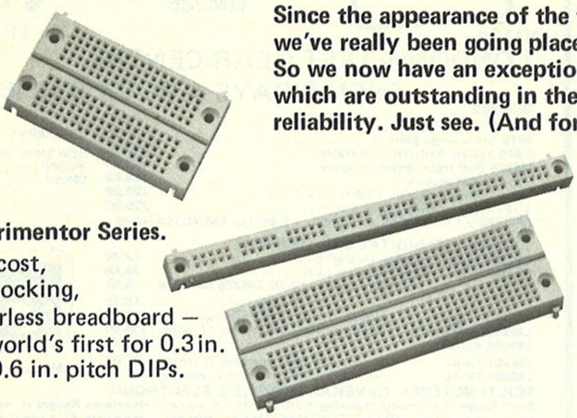

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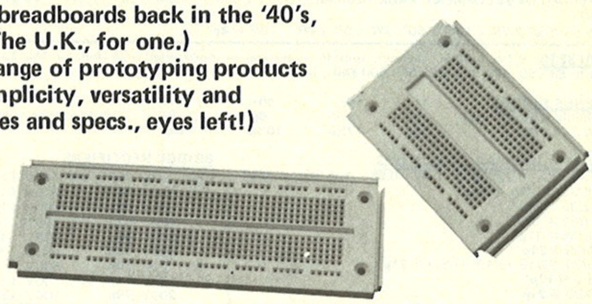

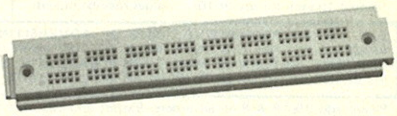

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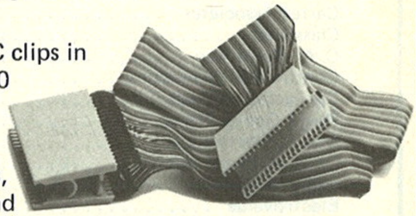

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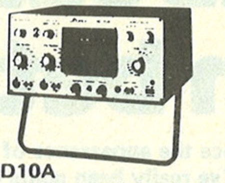

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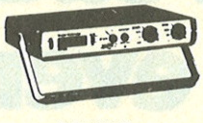
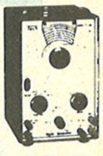


DM235



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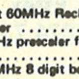

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TRANSISTORS

2N696	0.39	2N2220	0.39	2N3441	0.92	2N4122	0.27	2N5298	0.44	AC126	0.48	BC158B	0.15
2N697	0.31	2N2221	0.25	2N3442	1.45	2N4123	0.19	2N5447	0.16	AV127	0.48	BC159A	0.17
2N698	0.49	2N2221A	0.25	2N3638	0.17	2N4124	0.19	2N5448	0.16	AC128	0.48	BC159B	0.17
2N699	0.58	2N2222	0.25	2N3638A	0.17	2N4125	0.19	2N5449	0.20	AC129		BC160	0.38
2N706	0.30	2N2222A	0.25	2N3702	0.14	2N4126	0.19	2N5457	0.38	AC151	0.43	BC161	0.38
2N706A	0.30	2N2369	0.27	2N3703	0.14	2N4284	0.38	2N5458	0.35	AC152	0.54	BC167	0.13
2N708	0.30	2N2369A	0.27	2N3704	0.14	2N4286	0.22	2N5459	0.32	AC153	0.59	BC167B	0.13
2N718	0.30	2N2646	0.80	2N3705	0.14	2N4287	0.22	2N5460	0.65	AC153K	0.59	BC168A	0.13
2N718A	0.54	2N2647	1.55	2N3706	0.14	2N4288	0.22	2N5484	0.37	AC176K	0.70	BC168B	0.13
2N720A	0.85	2N2903	1.60	2N3707	0.14	2N4289	0.22	2N5485	0.40	AC176	0.54	BC168C	0.13
2N722	0.45	2N2904	0.31	2N3708	0.12	2N4347	2.20	2N5486	0.40	AC187	0.59	BC169B	0.13
2N727	0.50	2N2904A	0.31	2N3709	0.12	2N4348	2.65	2N5490	0.64	AC187K	0.65	BC169C	0.13
2N914	0.38	2N2905	0.31	2N3771	2.16	2N4918	0.65	2N5492	0.64	AC188	0.54	BC177	0.22
2N916	0.33	2N2905A	0.31	2N3772	2.20	2N4919	0.70	2N5494	0.65	AC188K	0.65	BC177A	0.22
2N917	0.38	2N2906	0.25	2N3773	3.15	2N4920	0.83	2N5496	0.67	AD161	1.00	BC177B	0.25
2N929	0.45	2N2906A	0.25	2N3819	0.36	2N4921	0.54	2N6027	0.64	AD162	1.00	BC178	0.22
2N929A	0.37	2N2907	0.25	2N3820	0.39	2N4922	0.60	2N6107	0.45	AF106	0.60	BC178A	0.25
2N930	0.37	2N2907A	0.25	2N3821	0.96	2N4923	0.75	2N6108	0.55	AF109	0.52	BC178B	0.35
2N930A	0.95	2N2923	0.17	2N3900	0.28	2N4924	1.15	2N6109	0.55	BC107	0.16	BC179	0.25
2N1711	0.30	2N2924	0.17	2N3901	0.30	2N5086	0.30	2N6111	0.49	BC107A	0.16	BC179A	0.25
2N1889	0.30	2N2925	0.19	2N3903	0.20	2N5087	0.30	2N6121	0.41	BC107B	0.16	BC179B	0.25
2N1890	0.30	2N2926	0.17	2N3904	0.18	2N5088	0.30	2N6122	0.44	BC108	0.16	BC179C	0.26
2N1893	0.30	2N3053	0.25	2N3905	0.18	2N5089	0.30	2N6123	0.48	BC108A	0.16	BC182	0.12
2N2102	0.50	2N3054	0.72	2N3906	0.18	2N5190	0.65	2N6124	0.45	BC108B	0.16	BC182A	0.12
2N2192	0.58	2N3055	0.75	2N4031	0.55	2N5191	0.75	2N6125	0.47	BC108C	0.17	BC182B	0.13
2N2193	0.50	2N3390	0.50	2N4032	0.65	2N5192	0.80	40361	0.55	BC109	0.16	BC182L	0.15
2N2193A	0.52	2N3391	0.40	2N4036	0.72	2N5193	0.75	40362	0.55	BC109B	0.17	BC182LA	0.15
2N2194	0.42	2N3391A	0.45	2N4037	0.60	2N5194	0.80	40363	1.45	BC109C	0.18	BC182LB	0.15
2N2194A	0.45	2N3392	0.17	2N4058	0.22	2N5195	0.97	40408	0.82	BC140	0.30	BC183	0.12
2N2195	0.40	2N3393	0.17	2N4059	0.17	2N5245	0.38	40409	0.82	BC141	0.32	BC183A	0.12
2N2195A	0.40	2N3394	0.17	2N4060	0.22	2N5246	0.44	40410	0.82	BC147	0.13	BC183B	0.13
2N2217	0.55	2N3395	0.19	2N4061	0.19	2N5247	0.44	40411	3.10	BC147B	0.13	BC183C	0.13
2N2218	0.35	2N3396	0.19	2N4062	0.20	2N5248	0.44	40594	0.87	BC148	0.13	BC183L	0.15
2N2218A	0.38	2N3397	0.19	2N4064	1.35	2N5294	0.44	40595	0.98	BC148B	0.13	BC183LA	0.15
2N2219	0.38	2N3438	0.85	2N4074	2.65	2N5295	0.44	40673	0.80	BC148C	0.13	BC183LB	0.15
2N2219A	0.39	2N3440	0.75	2N4121	0.27	2N5296	0.44	40669	1.30	BC149	0.15	BC183LC	0.15

BC184	0.12	BC301	0.43	BD140	0.43	BD538	0.77	BF259	0.35	ME0404	0.17	TIP31A	0.54
BC184B	0.13	BC302	0.37	BD181	1.90	BD539	0.60	BF336	0.42	ME0412	0.22	TIP31C	0.72
BC184C	0.13	BC303	0.54	BD182	2.20	BD540	0.60	BF337	0.49	ME0414	0.22	TIP32A	0.59
BC184L	0.15	BC307	0.16	BD183	2.35	BDX14	1.32	BF338	0.52	ME4001	0.16	TIP32C	0.82
BC184LB	0.15	BC307A	0.16	BD187	0.95	BDX18	1.90	BFR39	0.30	ME4002	0.16	TIP41A	0.76
BC184LC	0.15	BC307B	0.16	BD235	0.46	BDY20	1.10	BFR40	0.29	ME4003	0.16	TIP41C	0.97
BC212	0.15	BC308	0.16	BD236	0.44	BDY55	1.90	BFR41	0.30	ME4101	0.11	TIP42A	0.86
BC212A	0.15	BC308B	0.16	BD237	0.44	BDY56	2.10	BFR79	0.30	ME4102	0.11	TIP42C	1.08
BC212B	0.15	BC309A	0.16	BD238	0.44	BF115	0.39	BFR80	0.30	ME4103	0.11	TIP2955	0.70
BC212L	0.18	BC309B	0.16	BD239A	0.44	BF160	0.33	BFR81	0.30	ME4104	0.11	TIP3055	0.59
BC212LA	0.18	BC309C	0.16	BD239C	0.59	BF161	0.65	BFX29	0.34	ME6101		TIS34	1.05
BC212LB	0.18	BC327	0.22	BD240A	0.49	BF167	0.37	BFX30	0.34	ME6102		TIS42	0.50
BC213	0.15	BC328	0.20	BD240C	0.59	BF173	0.37	BFX84	0.30	MJ2955	1.35	TIS43	0.47
BC213A	0.15	BC337	0.20	BD241A	0.49	BF177	0.27	BFX85	0.38	MJE340	0.62	TIS90	0.22
BC213B	0.15	BC338	0.23	BD241C	0.65	BF178	0.27	BFX86	0.30	MJE370	0.62	TIS91	0.27
BC213C	0.15	BC547	0.13	BD242A	0.55	BF179	0.33	BFX87	0.35	MJE371	0.86	TIS92	0.33
BC213L	0.17	BC547A	0.13	BD242C	0.62	BF180	0.37	BFX88	0.30	MJE520	0.50	TIS93	0.36
BC213LA	0.17	BC547B	0.13	BD243A	0.65	BF181	0.37	BFX89	1.37	MJE521	0.70	ZTX300	0.17
BC213LB	0.17	BC548	0.13	BD243C	0.87	BF182	0.37	BFY50	0.27	MJE2955	1.65	ZTX301	0.17
BC213LC	0.17	BC549	0.14	BD244A	0.70	BF183	0.44	BFY51	0.27	MPF3055	1.05	ZTX302	0.27
BC214	0.17	BC549B	0.14	BD244C	0.87	BF184	0.41	BFY52	0.27	MPF102	0.33	ZTX303	0.27
BC214B	0.17	BC549C	0.15	BD245A	0.69	BF185	0.37	BFY90	1.35	MPF103	0.44	ZTX304	0.27
BC214C	0.17	BC557	0.14	BD245C	0.85	BF194	0.16	BR101	0.55	MPF104	0.44	ZTX330	0.22
BC214L	0.18	BC558	0.13	BD246A	0.72	BF195	0.16	BRY39	0.55	MPS105	0.44	ZTX500	0.16
BC214LB	0.18	BC559	0.15	BD246C	0.93	BF196	0.16	BSX19	0.35	MPSA05	0.27	ZTX530	0.25
BC214LC	0.18	BCY70	0.21	BD433	0.44	BF197	0.18	BSX20	0.35	MPSA06	0.27		
BC237B	0.15	BCY71	0.26	BD434	0.46	BF198	0.19	BSX21	0.35	MPSA12	0.44		
BC238A	0.13	BCY72	0.18	BD435	0.46	BF199	0.19	BU104	1.80	MPSA14	0.33		
BC238B	0.13	BD115	0.88	BD436	0.46	BF224J	0.22	BU105	1.55	MPSA55	0.27		
BC238C	0.13	BD131	0.55	BD437	0.55	BF225J	0.27	BU126	1.08	MPSA56	0.27		
BC239B	0.16	BD132	0.75	BD438	0.55	BF244A	0.38	BU204	2.20	R2008B	2.45		
BC239C	0.17	BD135	0.40	BD529	0.49	BF244B	0.33	BU205	2.40	R2010B	2.15		
BC257A	0.18	BD136	0.40	BD530	0.55	BF245A	0.44	BU206	2.70	TIP29A	0.49		
BC258B	0.19	BD137	0.41	BD535	0.70	BF245B	0.44	BU208	2.70	TIP29C	0.65		
BC259B	0.19	BD138	0.41	BD536	0.70	BF257	0.35	ME0401	0.22	TIP30A	0.54		
BC300	0.43	BD139	0.43	BD537	0.74	BF258	0.35	ME0402	0.22	TIP30C	0.70		

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CA3020A	2.50	LM723C	0.75	TAA550	0.48
CA3028A	0.90	LM723C14	0.45	TAA560	2.10
CA3028B	1.25	LM726	5.80	TAA570	2.20
CA3030	1.50	LM741C	0.70	TAA370A	5.45
CA3030A	2.20	LM741C8	0.30	TAA630	2.40
CA3038	2.90	LM741C14	0.30	TAA960	3.90
CA3038A	4.10	LM747CN	0.99	TAA970	4.20
CA3045	1.55	LM7488	0.50	TAA611B	2.50
CA3046	0.77	LM74814	0.90	TAA621	2.50
CA3048	2.45	LM1303N	1.15	TAA661A	1.65
CA3052	1.78	LM1304N	1.52	TAA661B	1.45
CA3080	0.85	LM1305N	1.52	TAA700	4.50
CA3080A	2.10	LM1307N	1.22	TAA930A	1.45
CA3086	0.50	LM1310N	2.10	TAA930B	1.45
CA3088B	1.87	LM1351N	1.30	TAD100	2.00
CA3089B	2.90	LM1458N	0.45	TBA120	0.80
CA3090Q	4.40	LM1496N	0.97	TBA500	2.24
CA3130	1.06	LM1808N	2.10	TBA500Q	2.34
CA3140	1.04	LM1812N	6.20	TBA510	2.35
LM301	0.30	LM1820N	1.16	TBA510Q	2.48
LM307N	0.50	LM1828N	1.90	TBA520	2.60
LM308N	0.95	LM1830N	1.90	TBA520Q	2.70
LM309KC	1.95	LM1841N	1.90	TBA530	2.35
LM317K	3.35	LM1845N	1.50	TBA530Q	2.45
LM318N	2.45	LM1848N	1.98	TBA540	2.60
LM3201 5	2.15	LM1850N	1.90	TBA540Q	2.70
LM3201 12	2.15	LM1889N	4.90	TBA550	3.60
LM3201 15	2.15	LM3301N	0.60	TBA550Q	3.80
LM3201 24	2.15	LM3302N	0.55	TBA5600Q	3.00
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LM320P 12	1.15	LM3900N	0.68	TBA570Q	2.20
LM320P 15	1.15	LM3905N	1.15	TBA700Q	2.20
LM320P24	1.15	LM3909N	0.78	TBA720AQ	2.06
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LM3401 15	0.88	LM324	0.75	TBA810S	1.30
LM3401 24	0.88	LM7815K	1.75	TBA820	0.80
LM341P 5	0.80	LM7824K	1.75	TBA920	2.99
LM341P 12	0.80	LM78L0602	0.30	TCA160C	2.36
LM341P 15	0.80	LM78L1202	0.30	TCA160B	2.55
LM341P 24	0.80	LM78L15C2	0.30	TCA270	2.99
LM348N	0.95	MM5314	4.60	TCA730	4.50
LM358N	0.60	MM5316	4.60	TCA740	4.50
LM360N	3.00	NE555	0.33	TCA750	3.00
LM370N	3.30	NE556	0.85	TCA760	2.00
LM371H	2.35	NE558N	1.98	TCA105	1.49
LM350K	6.45	NE560	4.50	TCA440	1.65
LM373N	3.35	NE561	4.50	TDA1022	7.50
LM374N	3.36	NE562	4.50	TDA1024	1.24
LM377N	1.80	NE565	1.39	TDA1034	4.75
LM378N	2.40	NE566	1.75	TDA2020AD	4.50
LM379S	4.25	NE567	1.90	UAA170	2.15
LM380N8	0.96	NE571N	4.96	UAA180	2.15
LM380N14	1.08	SAS60	2.70	TL080CP	1.25
LM381AN	2.70	SAS70	2.70	TL091CP	0.90
LM381N	1.69	SAJ110	2.10	TL082CP	1.10
LM382N	1.32	SO41P	1.35	TL083CN	1.40
LM384N	1.55	SO42P	1.36	TL084CN	1.45
LM386N	0.88	SN76001N	1.30	LF355N	0.80
LM387N	1.10	SN76003N	2.38	LF356N	0.80
LM388N	1.00	SN76013N	1.50	LF357N	0.80
LM389N	1.00	SN76023N	1.50	LF13201N	3.00
LM702C	0.81	SN76033N	2.35	LF13331N	3.00
LM709	0.70	TAA263	1.36	LF13741H	0.80
LM7098	0.50	TAA300	3.70	LF13741N	0.55
LM70914	0.49	TAA320A	1.15		

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4006	1.25	4019B	0.52	4037	1.20	4054	1.48	4073B	0.24	4096	1.30
4007	0.22	4020B	1.15	4041B	0.85	4055	1.65	4075B	0.24	4097	4.65
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4009	0.58	4022B	1.00	4043	1.05	4059	6.00	4077	0.70	4510B	1.20
4010	0.58	4023B	0.22	4044	1.00	4060B	1.15	4078	0.27	4511	1.75
4011B	0.22	4024B	0.76	4045	1.76	4063	1.35	4081B	0.24	4516	2.10
4012	0.22	4025B	0.22	4046B	1.50	4066B	0.75	4082	0.27	4518B	1.20
4013B	0.52	4027B	0.55	4047B	0.96	4067	4.85	4085	0.89		
4014	1.00	4028B	0.92	4049	0.96	4068	0.27	4086	0.89		
4015	1.05	4029B	1.10	4050B	0.85	4069B	0.24	4089B	2.10		

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74LS00N	0.26	74LS162N	1.43	7408N	0.22	74148N	1.35
74LS01N	0.26	74LS163N	0.85	7409N	0.22	74145N	0.86
74LS02N	0.26	74LS164N	1.43	7410N	0.20	74148N	1.35
74LS03N	0.26	74LS168N	2.43	7411N	0.26	74150N	1.20
74LS04N	0.29	74LS169N	2.43	7412N	0.20	74151N	0.76
74LS08N	0.26	74LS174N	1.33	7413N	0.36	74153N	0.76
74LS10N	0.26	74LS175N	1.26	7414N	0.80	74154N	1.20
74LS12N	0.26	74LS181N	3.95	7416N	0.36	74155N	0.70
74LS13N	0.58	74LS189N	3.74	7417N	0.36	74157N	0.78
74LS14N	1.43	74LS190N	1.00	7420N	0.22	74160AN	1.10
74LS20N	0.26	74LS191N	1.00	7423N	0.32	74161AN	1.10
74LS26N	0.39	74LS192N	1.98	7425N	0.32	74162AN	1.10
74LS27N	0.50	74LS193N	1.98	7427N	0.32	74163AN	1.10
74LS28N	0.42	74LS196N	1.28	7430N	0.22	74164N	1.36
74LS30N	0.26	74C00N	0.24	7432N	0.30	74165N	1.36
74LS32N	0.27	74C02N	0.24	7437N	0.35	74167N	2.50
74LS37N	0.32	74C04N	0.24	7438N	0.32	74174N	1.60
74LS38N	0.32	74C08N	0.24	7440N	0.20	74175N	1.00
74LS40N	0.29	74C10N	0.24	7441AN	0.84	74176N	0.90
74LS42N	1.07	74C14N	1.41	7442N	0.76	74177N	0.90
74LS47N	1.09	74C20N	0.24	7445N	1.40	74180N	1.00
74LS48N	1.09	74C30N	0.24	7446N	0.90	74181N	2.00
74LS49N	1.09	74C32N	0.24	7447N	0.80	74182N	0.80
74LS51N	0.26	74C42N	0.92	7448N	0.80	74184N	1.50
74LS54N	0.26	74C48N	1.38	7450N	0.22	74185AN	1.50
74LS73N	0.42	74C73N	0.54	7451N	0.22	74188AN	3.25
74LS74N	0.42	74C74N	0.56	7453N	0.22	74189N	2.60
74LS75N	0.58	74C76N	0.54	7454N	0.22	74190N	1.40
74LS76N	0.42	74C83N	1.30	7460N	0.22	74191N	1.20
74LS78N	0.42	74C85N	1.30	7470N	0.46	74192N	1.20
74LS83AN	1.20	74C86N	0.64	7472N	0.30	74193N	1.20
74LS85N	1.10	74C89N	4.39	7473N	0.44	74196N	1.20
74LS86N	0.44	74C90N	0.85	7474N	0.32	74197N	1.00
74LS90N	1.10	74C93N	0.85	7475N	0.80	74198N	2.00
74LS91N	1.20	74C95N	1.04	7476N	0.45	74199N	2.00
74LS92N	0.86	74C107N	1.22	7480N	0.60		
74LS93N	1.10	74C150N	4.14	7481N	1.00		
74LS95AN	1.10	74C151N	2.47	7482N	0.90		
74LS96N	1.35	74C154N	3.68	7483N	1.05		
74LS107N	0.42	74C157N	2.21	7484N	1.20		
74LS109N	0.42	74C160N	1.11	7485N	1.36		
74LS122N	0.80	74C161N	1.11	7486N	0.36		
74LS123N	0.83	74C162N	1.11	7489N	2.45		
74LS124N	2.70	74C163N	1.11	7490AN	0.45		
74LS125N	0.50	74C164N	1.04	7491AN	0.85		
74LS126N	0.50	74C165N	1.04	7492N	0.45		
74LS132N	0.85	74C173N	0.90	7493N	0.45		
74LS136N	0.44	74C174N	0.90	7494N	0.90		
74LS138N	0.65	74C175N	0.90	7495N	0.76		
74LS139N	0.65	74C192N	1.11	7496N	0.70		
74LS145N	1.30	74C193N	1.11	7497N	1.95		
74LS151N	1.07	74C195N	1.04	74100N	1.40		
74LS153N	0.58	7400N	0.17	74107N	0.35		
74LS154N	1.45	7401N	0.17	74118N	0.95		
74LS155N	1.20	7402N	0.17	74119N	1.40		
74LS156N	1.20	7403N	0.17	74121N	0.28		
74LS157N	0.60	7404N	0.17	74122N	0.55		
74LS158N	0.65	7405N	0.22	74123N	0.55		
74LS160N	1.43	7406N	0.56	74125N	0.45		
74LS161N	0.85	7407N	0.55	74141N	0.86		

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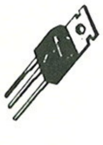

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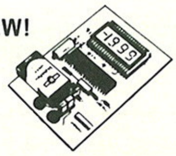

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7403	14p
7404	14p
7405	14p
7406	40p
7407	40p
7408	20p
7409	20p
7410	15p
7411	20p
7412	20p
7413	30p
7414	60p
7416	30p
7417	30p
7420	15p
7421	30p
7422	20p
7423	25p
7425	25p
7426	25p
7427	25p
7428	40p
7430	15p
7432	25p
7433	40p
7437	25p
7438	25p
7440	15p
7441	65p
7442	65p
7443	110p
7444	110p
7445	80p
7446	85p
7447	75p
7448	70p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	30p
7474	30p
7475	30p
7476	30p
7480	45p
7481	95p
7482	80p
7483	85p
7484	90p
7485	100p
7486	30p
7489	250p
7490	35p
7491	75p
7492	45p
7493	40p
7494	80p
7495	60p
7496	70p
7497	250p
74100	95p
74104	40p
74105	40p
74107	30p
74108	125p
74166	125p
74109	50p
74118	90p
74120	99p
74121	25p
74122	40p
74123	60p
74125	50p
74126	50p
74128	75p
74130	130p
74131	100p
74132	65p
74135	100p
74136	80p
74137	100p
74138	125p
74141	60p
74142	270p
74143	270p
74144	270p
74145	75p
74147	230p
74148	160p
74150	120p
74151	65p
74153	65p
74154	120p
74155	70p
74156	70p
74157	70p
74160	90p
74161	90p
74162	90p
74163	90p
74164	125p
74165	125p
74167	325p
74170	200p
74173	150p
74174	100p
74175	75p
74176	100p
74177	100p
74178	140p
74179	140p
74180	100p
74181	200p
74182	75p
74184	150p
74185	150p
74188	350p
74189	350p
74190	140p
74191	140p
74192	120p
74193	120p
74194	100p
74195	75p
74196	100p
74197	100p
74198	165p
74199	185p
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CA3130	100p
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LM300 T05	170p
LM301 AN	35p
LM304	250p
LM307N	65p
LM308 T05	130p
LM308 DIL	130p
LM309K	100p
LM310 T05	150p
LM311 T05	260p
LM317K	325p
LM324	150p
LM348N	200p
LM380N	110p
LM382N	135p
LM391	180p
LM555	28p
LM709C	50p
LM710 T05	60p
LM710 DIL	65p
LM723 T05	75p
LM723 DIL	75p
LM733	180p
LM741	25p
LM748	45p
LM1303N	155p
LM1458	100p
LM3080	90p
LM3900N	90p
MC1310P	185p
MC1312P	190p
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MM5314	430p
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NE556	100p
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SN76003N	180p
SN76013N	180p
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SN76023N	180p
SN76023ND	125p
SN76033N	180p
SN76227N	160p
SN76228N	180p
SN76660N	75p
TAA300	100p
TAA350	190p
TAA550	50p
TAA570	220p
TAA661B	140p
TAA700	390p
TAA790	350p
TAD100	160p
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AC151	25p
AC153	30p
AC153K	40p
AC154	30p
AC187	20p
AC188	20p
ACY17	35p
ACY19	35p
ACY20	35p
ACY22	40p
ACY40	50p
ACY41	50p
ACY42	50p
AD130	150p
AD143	150p
AD149	80p
AD161	40p
AD162	40p
AD161 2MP	90p
AF114	25p
AF115	25p
AF116	25p
AF117	25p
AF118	80p
AF178	95p
AF139	35p
AF239	45p
AF279	50p
AU110	180p
BA114	12p
BA121	12p
BA154	12p
BA157	15p
BA173	15p
BAX13	5p
BAX16	5p
BAW21	20p
BB105	35p
BB110	35p
BC107	10p
BC108	10p
BC108C	15p
BC109	10p
BC109C	15p
BC113	12p
BC114	15p
BC115	15p
BC116	15p
BC117	18p
BC118	12p
BC119	25p
BC125	16p
BC125B	20p
BC126	20p
BC134	15p
BC136	16p
BC137	16p
BC138	30p
BC140	30p
BC141	30p
BC142	30p
BC143	30p
BC147	10p
BC148	10p
BC148C	14p
BC149	10p
BC153	16p
BC154	13p
BC157	10p
BC158	10p
BC159	10p
BC167A	12p
BC168	14p
BC169	15p
BC171	12p
BC172	12p
BC177	15p
BC178	15p
BC182	10p
BC182L	12p
BC183	10p
BC183L	12p
BC184	10p
BC184L	12p
BC186	20p
BC204	12p
BC205	12p
BC207	12p
BC212	11p
BC212L	12p
BC213	12p
BC213L	15p
BC214	15p
BC214L	18p
BC237	10p
BC237B	15p
BC268	16p
BC294	30p
BC300	25p
BC301	25p
BC303	30p
BC307	15p
BC308	15p
BC317	12p
BC318	12p
BC323	30p
BC328	18p
BC337	20p
BC338	18p
BC348	20p
BC461	35p
BC516	50p
BC517	50p
BC547	12p
BC547B	13p
BC548	12p
BC548C	14p
BC549B	13p
BC549C	14p
BC557	13p
BC557B	15p
BCY34	80p
BCY38	100p
BCY42	25p
BCY43	25p
BCY58	18p
BCY59	25p
BCY70	15p
BCY71	20p
BCY72	15p
BD115	45p
BD121	85p
BD131	35p
BD132	35p
BD133	45p
BD135	35p
BD136	35p
BD137	40p
BD139	40p
BD140	40p
BD144	160p
BD181	100p
BD182	100p
BD188	130p
BD207	70p
BD220	65p
BD222	65p
BD233	50p
BD238	50p
BD242	60p
BD252	50p
BD263	65p
BD607	80p
BD608	80p
BD609	80p
BD610	80p
BD679	75p
BD680	75p
BDX32	200p
BDX42	50p
BDY10	100p
BF115	20p
BF120	50p
BF121	45p
BF123	45p
BF125	45p
BF127	50p
BF137	35p
BF154	18p
BF160	18p
BF161	18p
BF173	20p
BF178	25p
BF179	25p
BF180	30p
BF181	30p
BF182	30p
BF183	25p
BF184	20p
BF186	25p
BF194	10p
BF195	10p
BF196	10p
BF197	10p
BF198	25p
BF199	25p
BF200	30p
BF224	20p
BF225	20p
BF241	16p
BF244B	35p
BF255	25p
BF257	25p
BF258	25p
BF259	25p
BF271	25p
BF274	30p
BF324	30p
BF336	35p
BF337	35p
BF367	20p
BF394	35p
BF458	50p
BF594	50p
BF596	50p
BF597	50p
BFR40	30p
BFR80	30p
BFW58	20p
BFW60	25p
BFW88	30p
BFW89	30p
BFW91	30p
BFX29	25p
BFX34	25p
BFX38	25p
BFX44	35p
BFX48	45p
BFX81	100p
BFX85	30p
BFX87	25p
BFX88	25p
BFY10	30p
BFY18	100p
BFY19	100p
BFY50	20p
BFY51	20p
BFY52	20p
BFY53	25p
BFY90	125p
BR101	35p
BRY39	35p
BRY56	35p
BSX20	20p
BSY40	25p
BSY95	20p
BT100A	80p
BU105	200p
BU133	180p
BU208	220p
BY100	25p
BY126	15p
BY127	15p
BY164	56p
BY133	25p
BY164	50p
BYX94	8p
C1120	30p
C1164	20p
E100	42p
E201	50p
E204	45p
E300	47p
E310	60p
E420	180p
E420	125p
MJE340	45p
MPSA05	30p
MPSA06	32p
MPSA56	32p
TIP29	47p
TIP29A	49p
TIP29C	75p
TIP30	55p
TIP30A	58p
TIP30B	65p
TIP30C	80p
TIP31	55p
TIP31A	58p
TIP31B	65p
TIP31C	70p
TIP32	60p
TIP33	100p
TIP34	115p
TIP35	225p
TIP35C	250p
TIP41A	70p
TIP41B	75p
TIP41C	80p
TIP42A	80p
TIP42B	85p
TIP42C	90p
TIP2955	70p
TIP3055	50p
TIS90	25p
TIS91	25p
IN914	5p
IN3754	20p
IN4001	5p
IN4002	5p
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IN4004	5p
IN4005	5p
IN4006	6p
IN4007	7p
IN4148	4p
2N456A	90p
2N929	20p
2N930	20p
2N1302	25p
2N1303	30p
2N1305	30p
2N1306	38p
2N1308	50p
2N1711	22p
2N2219A	25p
2N2483	30p
2N2906	16p
2N2907	20p
2N3053	20p
2N3054	50p
2N3055	60p
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2.2 35	7p
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4.7 10	7p
4.7 16	7p
4.7 25	7p
4.7 50	7p
6.8 25	7p
10 10	7p
10 16	7p
10 25	7p
10 50	7p
22 6V3	7p
22 10	7p
22 16	7p
22 25	7p
22 35	7p
22/50	8p
33/6V3	7p
33/16	8p
33/25	8p
33/40	8p
33/50	9p
47 10	8p
47 16	8p
47 25	8p
47 35	8p
47 50	9p
100 10	8p
100 16	8p
100 25	8p
100/50	8p
100/63	16p
220/16	12p
220/25	14p
220/50	22p
330/25	17p
330/35	18p
330/50	20p
470 10	14p
470/25	19p
470/35	20p
470/50	24p
1000/16	27p
1000/25	30p
1000/35	35p
1000/40	40p
1000/63	50p
1200/63	60p
2200/10	30p

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25K LOG
50K LOG
100K LOG
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250K + 250K LIN or LOG
500K + 500K LIN or LOG
1M + 1M LIN or LOG
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4009	55p
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4013	50p
4015	90p
4016	40p
4017	90p
4018	90p
4020	100p
4022	90p
4023	16p
4024	65p
4025	16p
4026	160p
4027	50p
4028	90p
4029	110p
4030	55p
4032	96p
4035	120p
4043	250p
4046	150p
4047	100p
4048	55p
4049	40p
4050	40p
4054	120p
4055	140p
4056	135p
4060	120p
4066	55p
4069	20p
4070	25p
4071	16p
4072	16p
4077	35p
4081	16p
4082	16p
4510	120p
4518	130p
4520	130p
4528	100p

POLY CAPS

1000 PF	5p
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3300	5p
4700	5p
6800	5p
0.01 uF	5p
0.022 uF	5p
0.033 uF	5p
0.047 uF	5p
0.1 uF	6p
0.22 uF	7p
0.33 uF	9p
0.47 uF	12p
1.0 uF	20p
2.2 uF	25p
4.7 uF	35p
6.8 uF	40p

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LP1165	400p
LP1166	400p
LP1168	400p
LP1169	400p
LP1173	400p
LP1181	400p
LP1400	400p
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0.22/35V	14p
0.33/35V	14p
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0.47/35V	14p
0.68/35V	14p
1.00/10V	14p
1.00/35V	14p
1.5/35V	14p
2.2/25V	14p
2.2/35V	14p
3.3/16V	14p
4.7/16V	14p
4.7/25V	14p
4.7/35V	14p
6.8/6V3	14p
6.8/35V	14p
1.0/35V	14p
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